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THE OPTIC LOBES OF THE BEE'S BRAIN IN THE LIGHT OF RECENT NEUROLOGICAL METHODS.

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While studying the central mass of the brain of the common honey bee, which I have already described with some detail,[1] there was abundant opportunity offered for noting the finer structure of the so-called optic lobes. From the casual observations then made I take the following notes.

The general form of the optic lobes, as well as the cellular and fibrillar masses composing them, have been fairly well described by Berger, Viallanes and others for other hexapods, and what one finds in the bee does not differ materially from these early descriptions, so far as the inner two fibrillar masses are concerned (f. m. 2 and 3). In the bee I note that there are three of these fibrillar masses, all easily recognized in frontal, but less so in horizontal sections (f. m. 1). The outer mass presents a lunar appearance in frontal sections, and lies close inside the basement membrane of the retina, being separated from it by sufficient space for the entrance of large tracheal sacs and a thin layer of cells commingled with the fibers from the retina.

[1] The Brain of the Bee. Journ. Comp. Neurology. Vol. VI. Fasc. 3, 1896. pp. 133-210.

Earlier authors, from the time of the first good description of the finer structure of the optic lobes by Berger, to Carrière and Viallanes, evidently did not understand the significance of this outer fibrillar mass. Berger and Carrière considered it as forming a portion of the retina, and Viallanes found in it, in the case of the dragon-fly, structures that he denominated neuromatidia—structures unrecognizable in the bee, and really without existence in any of the arthropoda. The earlier description given by Hickson much more nearly approaches the truth, but this author erred in supposing what he saw to be protoplasmic reticuli. The first correct understanding of this body was arrived at by Parker, in his application of methylene -blue to *Astacus*. But between the crustacea, as noted by Parker, and the hexapoda, there are certain differences of detail that are readily apparent upon a comparison of the figure accompanying this paper and that given by the author mentioned.

Somewhat inside of this mass is the first or outer chiasma (x)—to be distinguished as such only in horizontal sections.

Concerning the two inner fibrillar masses it is to be noted that each is composed of two lenticular finally granular, or better, in the light of the new neurology, finely fibrillated masses separated by a loose mass of fibers that never assume so dark an appearance in the ordinary stains. Each body would, if it were a perfect segment of a sphere, form a meniscus lenticular mass whose convex surface is directed outward.

From the middle or second fibrillar body two tracts of fibers pass into the central cerebral mass as noted in my earlier paper. Each arises from the inter-lenticular mass of loose fibers and emerges at nearly the same spot with its fellow on the anterior side of the body. One passes inward and upward, becoming what I have called the *antero-superior optic tract*, which finally terminates among the dendritic fibrils of the cells of the adjacent mushroom bodies (*a-s o. t.*). The fibers of this tract originate, as has previously been pointed out, from a group of cells lying above the optic body (*op. b*) and below the anterior surface of the calyx of the outer mushroom body.

The cells and their processes passing inward towards the stalks of the mushroom bodies can be readily distinguished in

preparations by von Rath's platino-aceto-picro-osmic acid, or by my formalin-copper-hæmatoxylin, method, and in one instance I was able to follow through consecutive sections, in a bichromate of silver preparation, the entire course of the fibers from the cells in their antero-superior position in the central cerebrum to their T-like branching before the outer stalk, and thence into the inter-lenticular portion of the second fibrillar body.

The other group of fibers, after passing inward and slightly downward for a short distance, turns and passes backward between the inner fibrillar body and the central cerebrum, entering the latter posteriorly at a level below the roots of the mushroom bodies. This I have described as the *antero-posterior optic tract* (*a. p. o. t.*).

Just where the cells of origin of this tract of fibers are situated has not yet been determined. It may, however, be mentioned, that I have found in preparations by the bichromate of silver method, cells, situated near the anterior edge of the second fibrillar mass sending, in several cases, their processes into the loose inter-lenticular mass. It may be that these are the cells of origin of the tract (4).

Tracts of fibers are likewise found issuing from the interlenticular space of the inner or third fibrillar body. They are not, however, restricted to one spot in finding egress, but issue along the entire hinder margin of the body; and it is rather difficult to distinguish them otherwise than as the *posterior optic tracts.* Their number varies according to the plane of sectioning, and, it may be, also with different individuals. There are chiefly to be noted, however, first, an upper tract that seems to pass over the median line of the brain to the inner body of the opposite lobe. This tract undoubtedly gives off branches by the way, and it is possible that the cells of origin of its fibers are to be found on the posterior side of the brain below the inner mushroom bodies. At a level somewhat below the inner roots of the mushroom bodies there is another tract that takes a nearly straight course from one inner body to the other on the opposite side of the brain. From this tract Viallanes was unable to find evidence of lateral fibrillar

branches in the central cerebrum, and, after all the methods employed by me, I am compelled to say that I have been able to do little better. In one preparation by my formalin-hæmatoxylin method there seems to be evidence of such branches; but I have found no such evidence in bichromate of silver preparations. Finally, there are several small tracts below the last that terminate in the adjacent region of the central portion of the brain, and in the neighborhood of the terminations of the antero-posterior optic tract.

The situation of the cells of origin of these tracts has not been definitely determined, but some of them no doubt may be found in the neighboring posterior mass of cells (5 and 6).

Two other tracts of fibres leave the inner fibrillar body. From the inner or concave surface of this there issue a large number of fibers that appear to be gathered up into two bundles. One of these passes forward as the *anterior optic tract* and terminates in the optic body (a, o, t; op. b), a small oval mass of fibrillar substance just above the antennal lobe. The other passes upward as the *postero-superior optic tract.* It joins the antero-superior tract for a short distance, and then passes behind the stalks and apparently into the calices of the mushroom bodies.

To this description and the one I gave in my former paper one might object, basing the objection upon the course and peculiarities of the fibers of the antero-superior tract, that since there is a tract of fibers connecting the inter-lenticular space of the second fibrillar body with the calices of the mushroom bodies, one would expect to find this posterior tract making similar connections with the inner body. The point was a difficult one to decide, and caused me an expenditure of considerable time in coming to a conclusion; but the evidence of my sections, both those by the formalin-copper-hæmatoxylin and those by the bichromate of silver, especially the latter, method, appears to be in favor of the description that I have given.

Considering now the denser mass of the fibrillar bodies it may be said that in sections treated by the formalin-copper-hæmatoxylin method one may find evidence of fibers passing

through them in a direction nearly at right angles to their two surfaces. But such evidence is always fragmentary, and it is not until one employs the bichromate of silver method and thick sections that one is able to find unbroken individual fibres passing thus from one side to the other. Such fibers always show short arborescent branches in the outer and also in the inner lenticular mass. From the inner surface of the second fibrillar body they pass inward to the outer surface of the third body, which they enter, terminating arborescently a little below the surface. In this passage from one mass to the other they form, as seen in horizontal sections, a chiasma; so that a fiber emerging from the anterior side of the middle body enters on the posterior side of the inner body.

In many instances cellular connections were seen with the fragments of fibers crossing the masses and presenting the short lateral branches mentioned. In such instances the impregnated cells were found in the groups of cells lying anteriorly and posteriorly near the fibrillar bodies (2, 2′, 2″, 3, 3′, 3″). Their processes do not always enter the fibrillar bodies immediately upon reaching them, but run along the surface, curving around the fibers that do enter, and altogether presenting a somewhat lattice-like appearance when viewed at right angles to the surface of the body.

From the inner mass such crossing fibers have frequently been readily traceable into the anterior tract going to the optic body, but not into the postero-superior tract, which I was obliged to make out in heavily impregnated specimens.

From the outer surface of the middle body individual fibres have often been traceable nearly to the basement membrane of the retina, each posterior fiber crossing to the anterior side, forming with the anterior fibers the outer chiasma, and outside of this the peculiar palisade-like appearance that has been noted by the earlier authors.

Such fibers terminate proximally in the outer lenticular portion of the middle body in fine branchlets. Now and then a fiber entering this mass apparently from the palisade-like group of fibers gives off a few lateral branchlets and continues to the opposite side. Such cases I have interpreted to be the

processes of the cells belonging to this middle body, but which have not been impregnated.

In other instances than those showing the fibers throughout their course nearly to the basement membrane of the retina, one finds fibers, or fiber groups, entering from each retinal element and continuing for some distance in through the palisade of fibers.

In some cases cells belonging to the group just inside of the basement membrane, which were described by Berger as the cells of the granular layer, are found impregnated and with their processes connecting with the fibres just described. In other instances fibers with short lateral branchlets are to be noted, the branchlets occurring in the region of the outer fibrillar body.

From the details noted it appears that the elements from the retina terminate each in a small tuft of fine branches in the outer fibrillar body, and come in contact with the fine lateral branchlets given off in the same region by fibers originating from the cells in Berger's granular layer. These latter fibers, forming elements No. 1, then continue on through the outer body, forming the palisade-like arrangement of fibers and the outer chiasma, and finally terminate arborescently in the outer lenticular mass of the middle body. The reasons that fibers from the retina seem to cross the outer body, forming a continuous passage between the basement membrane and the middle body is, it seems, that the lateral branchlets of elements No. 1 are very short, and the two small fibers are so closely applied together as to appear as one where they are heavily impregnated with bichromate of silver.

From the elements forming the optic lobes of the higher crustucea, as described by Parker, these and the elements belonging to the middle and the inner fibrillar bodies, noted in the figure as elements 2 and 3 respectively, differ in not forming a T-like figure, or in having a group of short lateral dendrites rather than one dendritic branch. This difference, it is plain, depends upon the location of the cell-body of the element. In the crustacea the latter, as shown by Parker, is situated between the fibrillar bodies that the two branches of its process

connect. In the bee it is situated outside of the outer of the two bodies that are connected.

In summarizing the matter as just described, and as shown in my drawings and sections, it appears that, setting aside the outer or retinal elements, there are concerned in the transmission of visual stimuli to the central portion of the brain some six or seven neural elements, and that such stimuli may reach (1) the optic body, (2) the mushroom bodies, and (3) the hinder lower portion of the brain, and that they may pass over one or the other of the optic commissures—provided the upper one is a real commissure—to the inner fibrillar body of the opposite lobe, and thus indirectly reach the mushroom bodies, the optic body, and the posterior region of the brain on the opposite side. Further, it may be seen that there may be either three or four, or possibly more—but at least three—neural elements concerned in the transmission of a single stimulus. Thus, a stimulus may reach the optic body, the mushroom bodies, and the lower posterior portion of the brain as follows:

The mushroom bodies,	
By three elements,	1 a—2 b—(a.-s.ot.r.) or 1 a—2 b—3 d.
The optic body,	
By three elements,	1 a—2 b—3 d.
The lower-hinder brain,	
By three elements,	1 a—2 b—(a.p.t).
By four elements,	1 a—2 b—3 d—(p.o.t.).

Further it appears that a single stimulus might reach all three cerebral centers.

This explanation seems to accord best with the existence of two sets of fibrillar branchlets upon one element (b.c. and d.e.); but it must be held to be hypothetical, since I have not been able to ascertain definitely whether the terminals of the fibers of the posterior, the antero-superior, and the antero-posterior optic tracts connect only with the secondary branchlets (c and e). If connections are made with the primary sets (b and d) then the matter becomes much more complicated.

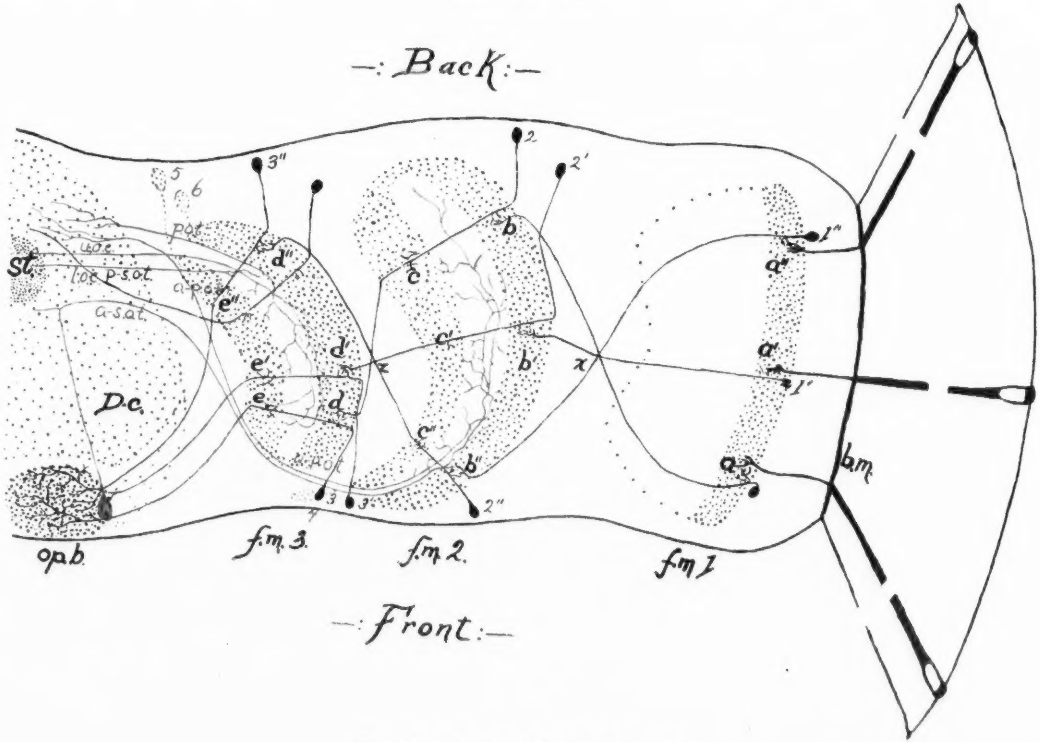
Explanation of Plate.

(DIAGRAMATIC.)

a, a′, a″.	Outer fibrillar connections in the outer fibrillar body.
a.o.t.	Anterior optic tract.[2]
a.–p.o.t.	Antero-posterior optic tract.
a.–s.o.t.	Antero-superior optic tract.
b, b′, b″.	Fibrillar connections in the outer lenticular mass of the middle body.
b.m.	Basement membrane of the retina.
c, c′, c″.	Fibrillar connections of the inner lenticular mass of the middle body.
d, d′, d″.	Fibrillar connections of the outer lenticular mass of the inner body.
D.c.	Dorso-cerebrum.
e, e′, e″.	Fibrillar connections of the inner lenticular mass of the inner body.
f.m. 1, 2, 3.	Fibrillar bodies 1, 2 and 3, or outer, middle, and inner.
l.o.c.	Lower optic commissure.
p.o.t.	Posterior optic tracts.
p.–s.o.t.	Postero-superior optic tract.
st.	Stalk of the outer mushroom body.
u.o.c.	Upper optic commissure.
4, 5, 6.	Supposed location of the cells of origin of the fibers of the *a.–p.o.t.* and the *p.o.t.*
x.	The outer chiasma.
z.	The inner chiasma.

[2] The tract to the optic body (op. b.)

PLATE IX.



The Optic Lobe of the Bee's Brain.

SOME NOTES ON THE FLORA AND FAUNA OF MAMMOTH CAVE, KY.[1]

By R. Ellsworth Call, Ph. D.

In 1889 there was published by the general government Dr. A. S. Packard's "Cave Fauna of North America, with Remarks on the Anatomy of the Brain and the Origin of the Blind Species," which constitutes the most complete treatise on cave animals which has appeared in this country. In that work there were listed eight genera and nine species of Infusoria, three genera and species of Vermes, four genera and species of Crustacea, eight genera and species of Arachnida, one of Myriopoda, twelve genera and fourteen species of Insecta, and two genera and species of fishes, all from Mammoth Cave. Dr. Packard also adds a list of seventeen forms said to be living temporarily in the cavern, most of which are listed on the authority of others. Of these one, *Spelerpes* or cave salamander, is listed on the uncertain authority of one of the guides. Excluding this list of seventeen, which includes three forms of *Helix* which most certainly came in from without, after death, and in floatwood, there remains a total of forty-one species. Seven of these are uncertain either in their generic or specific relations, as appears from the mark of doubt which is added to them. Of many of the forms concerning which there is no manner of doubt there are excellent descriptions and figures.

It is not my present purpose to speak of the forms which were known from Mammoth Cave prior to my own period of study, except in the most incidental manner. On the contrary, it is designed only to speak on the additions which more careful investigation has brought to light.

In the study of this new material the writer has been assisted by the following gentlemen, whose names are mentioned both that the fullest credit may be given them and that their high authority may attach to the determinations of the several forms

[1] Read before Indiana Academy of Science, December 30, 1896.

as being new. For the *Diptera*, Mr. D. W. Coquillett, of the Department of Agriculture, Washington; for the *Acarinæ*, *Thysanuræ*, *Therididæ* and related forms, Mr. Nathan Banks, of Sea Cliff, New York; for the microscopic plants, Dr. Roland Thaxter, of Harvard University. It is quite sure, therefore, that the determinations in these groups are quite accurate and authentic. For the single mollusk and the larger fungi the writer is alone responsible.

The conditions under which collections are made in Mammoth Cave are not of the simplest character. The cavern itself is very great, and the forms of life neither large, as a rule, nor abundant. Hours may be spent by a novitiate without any success attending his efforts, and it is only after much search and repeated failures that he begins to realize that the distribution of life within the cave obeys certain laws. Animals are not found everywhere; nor are they found in association, except in a few instances. Visitors frequently spend hours in the cavern and fail to see any evidence of life; but one who is somewhat familiar with the habits of insects soon discovers that the same principles which govern their distribution in the realms of light prevail in the subterranean world. In a short time one soon learns where not to look for life, a fact of as great importance to one whose time is limited as to know where to look. The darkness is inconceivably great, and hangs like a great burden on one who seeks the smaller forms. The crude methods of illumination avail to lighten but a small area at a time, and most of the forms appear to be sensitive to light while not possessing organs of vision; such, at least, is my conclusion after some years of collecting, though, it is true that the heat of the lamps may be the prime cause of the haste which many species evince when disturbed. From my experience in Mammoth Cave I have learned that it is practically useless to hunt for insects where the cave is very dry; regions of wet soil or sides are the most favorable localities for all the insecta. The smaller rills and springs in the cave usually contain an abundance of small crustaceans, but mainly of two forms; aside from these but one form of life is common in the water, or fairly so,

and that is the small white leech. An undetermined nematode worm, two specimens in all, has been found by the writer in a small rill which furnishes the water to Richardson's Spring, in the Labyrinth. On the walls about such places the "cave crickets" abound, and under the flat stones along the way may be found the very small and white spiders, associated with the small white and delicate *Campodea cookei.* Occasionally a brownish beetle, *Anophthalmus*, scurries across the over-turned stone, or may be seen running rapidly over the moist sands. In a few localities, where decaying toadstools are found, or where decaying vegetation of other sorts occurs, small flies occasionally appear fluttering in uncertain way about the lamps or run rapidly over the wet sand. In a single locality appears the minute mollusk, which we herein describe, the only known form which is a true cave mollusk in this cavern.

To the list of cave animals which appears in Packard's monograph must now be added seven forms, which are new to science, and several forms which, while known, have not before been definitely reported from Mammoth Cave. Without exception the new forms are very minute, and this fact is in itself sufficient to explain their late appearance in lists of the cave fauna. Without attempt to arrange them into strict systematic groups it will be enough to say that there is one new mollusk, one new dipterous insect, two new thysanurids, one new psocid, one new pseudoscorpionid, two new acarinids, among the animals; while several others have been collected in sufficiently great numbers to settle doubts connected with their affinities, or to make absolutely certain previous doubtful records or their occurrence. This is true of the two dipterous forms hitherto listed as *Sciara* and *Phora*, without specific names.

The descriptions which follow are prepared from the material collected by me by the gentlemen whose names are appended to the several forms, and the species are to be quoted with their names in authorship. This paper for the first time presents these new forms to science; their authors should have the fullest credit in citations. These new forms may be described as follows:

THYSANURA.

"*Entomobrya cavicola* Banks. Nov. sp. (Plate X, Fig. 2.)

"Length 2 mm. Whitish hyaline, intestine showing through darker; clothed with rather long scattered bristles and finer, shorter hairs; head not broader at tip in side view; no eyes; antennæ one-third longer than the head, first joint very short, second twice as long, third shorter, fourth longest; legs short, two claws at tips; mesothorax no longer than metathorax; first abdominal segment indistinct, fourth longer than third or second, fifth apparently entire, blunt at tip; furcula rather slender, mucrones curved. Several specimens. Mammoth Cave, Kentucky." (Banks.)

This minute species occurs in very great numbers in a single locality, a side avenue which leads over the narrow passage called the Labyrinth to the top of Gorin's Dome, in the older portion of the cave. In collecting it I had to lie on my face with the lamp close to the ground, and on turning over a fragment of an old wheel-barrow, that had been in the cave for two score or more years, and was so rotten that slight effort only was needed to tear it to bits, these little insects would be seen running about in every possible direction and in great haste. They were both on the under surface of the fragments of wood and also on the earth under them in equal numbers; when disturbed in the attempt to secure them the characteristic jumping movement of the group availed here to make collection difficult. It was noticed that many of them in springing up in the air would rise to an extraordinary height for so small an insect, frequently two or even three inches from the board. Others would land in nearly the same place as that from which they started, having a kind of boomerang movement that was, at least, curious. A paper bag would have secured hundreds by taking stick and all; but, as is usual on such occasions, the paper bag was not at hand. It is interesting to note, that while they represented a generation that must have been a long way from their beginning in the cave, introduced, of course, from the outside world originally, they still retained the habits of their earlier ancestors and of the group, and sought, in the

densest darkness, the security of the under surface of their shelters. It would seem that this habit, which is quite general for all the cave species observed by me, would be a strong argument in direct proof of the outside origin of the fauna as a whole. While many generations have passed these forms hide in the regions of perpetual darkness as completely and systematically as do their cousins and nearer relatives of the surface. It is further interesting to note that this species is eyeless, a fact to which Mr. Banks calls attention in his description.

"*Smynthurus mammouthia* Banks. Nov. sp. (Plate X, Fig. 1.)

"Length 1 mm. White hyaline. Eyes distinct; antennæ have the first joint very short; second twice as long; third equal to second; fourth much longer, divided into five parts, the basal one long, the following three short, subequal, and a longer, slender one at tip; all, except the last joint, with hairs at tip. Legs are moderately long, two claws at the tip, each with a tooth above, the outer claw as long as the width of the tibia. There is a small tooth below on the dentes before the tip, and a larger one on the outside at tip over the insertion of the mucrones; the latter are shorter than the dentes, finely serrate below and with curved tip. Quite a number of short hairs on the posterior half of the abdomen, and on the anal tubercle. Three specimens, Mammoth Cave, Kentucky." (Banks.)

Of these specimens one was found in association with the form described above, while two were found under damp stones near Richardson's Spring, in the Labyrinth. The form moves slowly about, under the influence of the heat from the lamps, but springs very like the *Entomobrya* when the attempt is made to take it. The white color alone enables one to detect it during its slow crawling movements; a considerable number escaped before they could be seized, dirt and all, by the forceps. I judge the species to be fairly common, since one of my notebooks records the form as occurring in some numbers as follows: "Small mite-like forms abundant under sticks near Richardson's Spring; with them are rare examples of *Anthrobia mammouthia* Telkpf." Mr. Banks' figures are very character-

istic, and well illustrate the hairy character of the animal. It has only occurred to me in this single locality, but may be found at other places in the cave where there are similar conditions of moisture.

PSOCIDÆ.

"*Dorypteryx* (?) *hageni* Banks. Nov. sp. (Plate X, Fig. 4.)

"Length 1.5 mm. Wholly pale, except reddish-brown eyes and mandibles. Head, thorax, legs and hind segments of abdomen clothed with fine short hairs. Ocelli sometimes distinct, sometimes not; basal part of antennæ of three joints, rest missing; maxillæ plainly trifid; legs slender, tibiæ much longer than femora, tarsi three-jointed, basal joint longest; wings rudimentary; second segment of the abdomen very long and smooth, subcylindric, forming the greater part of abdomen, on the venter it is prolonged by a median triangular piece over the next segment; other segments much shorter, and tapering to the tip.

"Several nymphs from Mammoth Cave, Ky. This may be the species to which Hagen refers in Packard's Cave Memoir, but it certainly is not the *Dorypteryx pallida* Aaron, which differs in broader nasus, more prominent eyes and larger thorax." (Banks.)

A number of specimens were found under wet and decaying fragments of boards in the Labyrinth in a small pit under the way leading to the top of Gorin's Dome. In this locality are the accumulations of many years of replacement of old bridges and steps which lead up the steep declivity which is so near the Dome, and the debris, well decayed and crumbling, affords the richest collecting ground in the cave. Spiders, flies, beetles, crickets, myriopods, mites all are here and the largest series to be found at any single place may be obtained. The particular forms which are the subject of this description find abundant food in the microscopic fungi which here abound.

ACARINA.

"*Rhagidia cavicola* Banks. Nov. sp. (Plate X, Fig. 3.)

"Length .7 mm. Whitish, legs hyaline. Cephalothorax pointed behind, and with a distinct segment behind it and be-

fore the abdomen, cephalothorax plainly longer than broad, truncate in front, no eyes; the abdomen rather narrow at base, broadest toward the middle and broadly rounded at the tip, showing above faint transverse marks or sutures; legs rather stout, with scattered bristles; mandibles large, chelate, a little shorter than cephalothorax, directed slightly downwards; palpi a little longer than the mandibles, second joint three times as long as broad, third fully twice as long as broad, and with two bristles at the tip, fourth about as long as broad, with five or six bristles at the tip arranged in a somewhat radiate fashion.

"Several specimens, Mammoth Cave, Kentucky." (Banks.)

This mite is a somewhat common species, and is found on the under side of stones in damp stations; especially may it be found under stones on which the egg masses of the cave spider, *Anthrobia mammouthia* Telkpf, occur. I do not know whether it attacks these masses in any way, but the association is suggestive of that conclusion. The species is one of the smallest of the living forms found in the cavern, being exceeded in that particular only by the following one. It has only occurred in collections from near the bottom of the Bottomless Pit and in Blacksnake Avenue, in which Richardson's Spring is located. More than two-thirds of all the species known from Mammoth Cave came from near this station or at it.

"*Linopodes mammouthia* Banks. Nov. sp. (Plate X, Fig. 5.)

"Length .5 mm. Pale yellowish, legs paler. Body oblong, rounded in front and behind; cephalothorax as broad as long, a shining eye on each side distinct; abdomen globose, above a silvery T mark, dorsum with a few hairs above, longer ones at the tip, and small ones each side of anal opening; leg I very long and slender, femur I as long as body, tibia shorter, metatarsus much longer than body, tarsus shorter, apparently not divided, femur IV thickened; the mandibles form a rather elongate cone; palpi plainly longer, joints two and three and subequal, smallest at base and rather clavate in form, fourth smaller and shorter.

"Several specimens from Mammoth Cave, Kentucky." (Banks.)

In all I have secured some fifteen specimens of this little acarinid, which is the smallest form yet discovered in the cavern. It occurs on the under side of damp stones and sticks, in association with the thysanurids, which are described herein, and is easily distinguished in collecting. The very long first pair of legs give it a most peculiar aspect, and as they are always in somewhat rapid motion they serve to discover the little insect to the observer. Then, too, the species has the curious habit of raising itself up so that it stands on the first and fourth pair of legs when disturbed. It is exceedingly slow in its movements. Vision is impossible in the cave, notwithstanding its bright eyes, and possibly the bristles or hairs of the posterior abdomen, on dorsal surface, have a certain tentacular function—using the word in the sense of organ of touch. It may be said that the species was originally detected, and subsequently always found, by lying prone on the ground and with the lamp as close as possible to both face and soil. The heat appears to disturb the minute specks of pale yellowish color, and they appear to move; then dirt and all were collected and transferred to the alcohol vial, and the microscope eventually discovered the animal. At the first and several following trials it was a matter of serious question whether I had really seen anything move, so small are the objects. Like many another form the original discovery of this one was an accident.

DIPTERA.

'*Limosina stygia* Coquillett. Nov. sp.

"Male and female specimens. Black, subshining, the palpi, front coxæ, apices of femora and bases of the tibiæ (most extended on the front pair), also bases of the tarsi and of the halteres, yellowish. Middle tibiæ each bearing a bristle on the outer side above the middle, a pair at the apex on the outer side and a single one on the inner side at the tip; hind tibiæ destitute of a spur at the tips; first joint of hind tarsi one and one-half times as thick as, but only two-thirds as long as, the second, twice as long as broad; second joint one and one-half times as broad as, and one and one-third times as long as, the third; remaining joints slightly broader than but only two-

PLATE X.

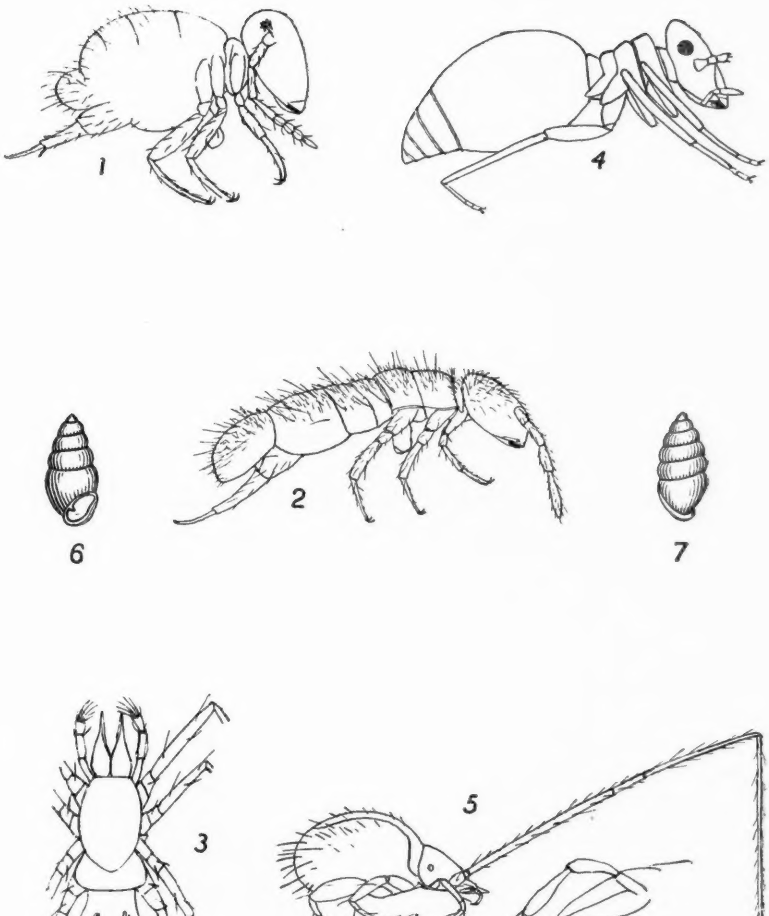
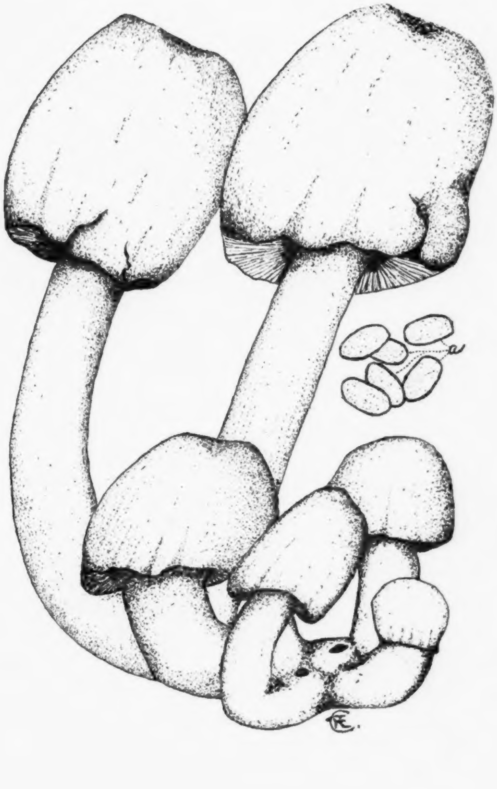


Fig. 1. *Smynthurus mammouthia* Banks. Fig. 2. *Entomobrya cavicola* Banks. Fig. 3. *Rhagidia cavicola* Banks. Fig. 4. *Dorypteryx* (?) *hageni* Banks. Fig. 5. *Linopodes mammouthia* Banks. Figs. 6–7. *Carychium Stygium.*

PLATE XI.



Coprinus micaceus.

thirds as long as the third. Scutellum bare, except for the four marginal bristles. Wings grayish hyaline, tip of second vein nearly midway between the apices of the first and third veins, third vein nearly straight, terminating close to the extreme wing-tip, fourth vein subobsolete beyond the discal cell, fifth vein continued beyond the hind cross-vein over one-half of the length of the latter, second basal and anal cells wanting. Length 1.5 mm. to 3 mm. Fifteen specimens, collected in alcohol, from Mammoth Cave, Kentucky." (Coquillett.)

A considerable number of additional specimens have been secured since the original lot which was forwarded to Mr. Coquillett, representing both sexes. These specimens and the original ones all came from the same parts of the cave, in which the species is fairly common. The number of individuals appears to be quite considerable, and many more could have been secured with a good net and proper appliances. The localities are all in River Hall, one near the Cascade, which is to the right of the visitor who crosses the Styx ; the other is near the head of Echo River. In both localities the floor of the cave is covered with a thick coating of rich mud, which contains enough dead organic matter to permit the rank growth of clumps of large hymenomycetous fungi of the genus *Coprinus*. In the decaying specimens of this fungus the flies are found, both in larval form and in imagos. They run about over the wet earth and clay rather briskly, or, if disturbed, fly a short distance and again settle down. The species is the smallest that is found in the cave. The body is, however, considerably heavier than that of the *Phora* which is herein described.

The two forms next following have been reported only by generic name from Mammoth Cave. The material collected by me was somewhat abundant, and definitely places these forms in the cave fauna. The original descriptions are given together with the bibliographic references ; these are followed by a new description prepared by Mr. Coquillett, based upon the males, in the first case, and upon specimens of both sexes in the description herein newly made.

Sciara inconstans Fitch.[2]

[2] First and Second Reports on the Noxious, Beneficial and other Insects of the State of New York, p. 255, 1856.

"It measures 0.08 in length, and is black, with the thorax smooth and slightly shining, the thighs pale and whitish, and the wings pellucid and glassy, with an iridescent violet and red reflection." (Fitch.)

This very brief and incomplete description, without access to the types, would hardly enable recognition of this form. To it may be added the following:

"Male. Brownish-black; bases of the halteres, coxæ, femora and tibiæ, yellow. Antennæ as long as the body. Each apical joint of the hypopygium bears a cluster of short spines on the apical third of the inner side. Wings grayish hyaline, strongly iridescent, veins brown, fourth vein more slender than the others, forking at a point beyond the tip of the first vein, equaling the greatest width of the marginal cell, the anterior fork as long as the preceding section of that vein; last section of the first vein about as long as the preceding section; costa gently convex on the basal half.

"Female. Same as the male, except that the antennæ are only half as long as the body. Last joint of the ovipositor nearly one-third longer than broad. Length 2 mm. to 4 mm." (Coquillett.)

A number of specimens, over twenty in all, were obtained at several points in Mammoth Cave. One locality is in the small dome in the Labyrinth, near the Bottomless Pit; another, is the Mammoth Dome, in another part of the cavern; a third is at Richardson's Spring, in Black-snake Avenue; and another is at the bottom of Gorin's Dome. At Richardson's Spring was found an apple quite decayed in which hundreds of the larval forms of this species were found, and nearly a hundred secured. Careful search in suitable localities failed to disclose the puparium of this form. It appears to be quite abundant in the damper portions of the cavern.

Phora rufipes Meigen.[3]

(Translation.) "Black, halteres white, legs reddish-yellow, wings hyaline. It differs from the foregoing [*annulata* Meig.

[3] Klassifikazion und Beschreibung der europaischen zweiflügligen Insekten, p. 313, 1804. (Work not accessible.)

Systematische Beschreibung der bekannten europaischen zweiflügligen Insekten, pp. 216-217, 1830.

=*rufipes* Meig.] only in lacking the white sutures on the abdomen. The male has a nearly conical, long haired body. One line."

Mr. Coquillett has prepared the following description from my specimens:

"*Phora rufipes* Meigen. Male and female. Brownish-black, palpi, halteres and legs yellowish. The four lowest median frontal setæ directed downward. Legs destitute of bristles except a pair at tip of inner side of each middle tibia and a single bristle at tip of inner side of each hind tibia. Abdomen of the male covered with rather long and nearly erect bristles. Wings hyaline, costa from base to tip of second heavy vein fringed with rather long bristles, second heavy veins forked at the apex, first slender vein arcuate at the base, then nearly straight to the tip. Length 2 mm. to 3 mm." (Coquillett.)

This species appears to be less abundant than either of the other dipterous forms. It occurs in Mammoth Dome and in the Labyrinth, in association with the *Sciara inconstans*. It flies about more freely, and when disturbed does not again light near by. In the Mammoth Dome I found the species running about among the masses of *Rhizomorpha*, which are so abundant on very old and decayed timbers in that portion of the cave.

MOLLUSCA.

Carychium stygium. Nov. sp. (Plate X, Figs. 6–7.)

Shell minute, white, pellucid, shining; whorls 5 to 5.5 in number, convex above and rather flattened below, apical whorl blunt-rounded in most specimens, occasionally more acute; suture deeply impressed, quite regular; aperture a little less than one-fourth total length of the shell, rather sharply angular above and broadly rounded below, with its plane forming a very acute angle with axis of the shell; lip reflexed in mature specimens; many examples, but not all, with a sharp, white, and long denticle on the parietal wall near the junction of the upper portion of the apertural boundary; the spire is generally quite regularly and narrowly conical, but the body whorl is

somewhat turgid. The length of the shell is 1.5 mm. to 1.85 mm. The aperture is nearly as broad as long. (Call.)

About 150 examples of this minute mollusk were secured during various visits to Mammoth Dome, in Mammoth Cave. They were found on the wet surfaces of the old bridge timbers, in that portion of the cavern, which have remained undisturbed for fifty or more years. Growing on these in great tufts or masses, forming a shaggy mantle that enveloped the great timbers throughout their length, was a species of *Rhizomorpha*, a peculiarly modified and sterile form of basidiomycetous fungus; in the midst of this fungous growth occur numerous examples of this shell. Occasional specimens are found on the under surfaces of the wet rocks of this part of the cave, but none have ever been taken in a dry situation in the Dome. The constant dripping of water, which in the wet season is a stream falling from the roof 150 feet above, keeps the rocks and old timbers, with their fungous growths, all continually wet, and, except the utter darkness, makes the place a desirable home for "a well brought up" *Carychium.*

This species is much smaller in the relative size of the aperture and length of shell than its nearest ally *Carychium exiguum* Say. But it is a much heavier shell, far more rounded and shining than that form. *Carychium exiguum* from Indiana and and New York, with which I have compared it, is a much slenderer shell. Compared with the doubtful *Carychium exile* Lea it has a broader body whorl, is more conical, and has no striations, which are marked features of that form. Compared with the so-called *Carychium occidentale* the shape and size of the body whorl are different, the form of the lip and the curvature of the outer lip above are distinct. Since our form seems to be constant in all these differences it has been decided to present it under the name of *Carychium stygium.* Specimens may be seen in the Academies of Natural Sciences of Philadelphia and Cincinnati, and in the United States National Museum. The types are in the Call Collection at the Indiana State University, Bloomington.

The remainder of the new forms are plants, and but a brief mention will be made of them. Several of the lower fungi

have been reported from Mammoth Cave, but most of them with doubt. Among the larger fungi Hovey has reported a species of *Agaricus*, which, however, seems to have been wrongly determined, since the form is a *Coprinus*. Collections were made at various localities; indeed, at all places in the cave where plant life occurs at all. While these have not all been carefully studied certain facts of interest have been gleaned. These now follow.

The largest form known in the cave is *Coprinus micaceus* (Plate XI). This occurs only in River Hall, near the Cascades and at various points between them and the head of Echo River. The last locality seems to be extremely well suited to them, for they grow in some numbers, and in clusters of several individuals. As is well known, the pileus of the *Coprini* is deliquescent. The particular form from the cave has black and rather large spores, and when, in maturity, the form deliquesces, it runs over a considerable area of the wet soil surrounding it and makes large black patches of sticky or gelatinous matter. In the midst of this black area, for some two or three days, the stipe will remain standing and afford attractive bits for *Adelops* and *Phora*, the first a beetle, the second a fly. In the pileus, before deliquescence is completed, the beetles and flies alike may be found in the burrows which the former have made. Many larvæ were obtained through a close examination of fifty or more specimens, at one time or another. The fungus itself thrives in the rich mud of the river banks, where sufficient organic matter is buried, and specimens have been seen with long and curled stipes of more than thirteen inches length. A locality where the species may always be found is at the third arch or landing on the Echo River, on the steep muddy banks of the river near the bridge.

On the old timbers in Mammoth Dome and on those of the little pit near Gorin's Dome, in the Labyrinth, occurred in great numbers a small *Peziza*, very light reddish-brown in color and thriving well, though growing in absolute darkness. In the Mammoth Dome the form must have long sustained itself, for it has been many years since timbers were placed there; unless, indeed, the spores were introduced in a very likely manner, on

the smaller tree timbers, which are used in the construction of the railings and walks along the Styx and the Dead Sea. These are taken into the cave by way of Little Bat Avenue, and Mammoth Dome, being let down from the top, and thence taken by Spark's Avenue to River Hall. Whether this be the real manner of spore introduction matters little; it is important to note that a form which almost commonly needs the light and warmth of sunshine to develop well here apparently thrives in absolute darkness and at a temperature which averages 54°.

In this same locality occurs the problematical form of basidiomycetous fungus, which is called *Rhizomorpha molinaris?*, living in the greatest profusion on the old sticks and timbers which here abound. Some specimens of beams that have remained in the lowest and wettest portion of the Mammoth Dome for many years are covered from one end to the other with the long root-like filaments of this plant. The greater number of the living filaments were of a deep brownish color, shading into a very light red tip, which became colorless at the extreme end. They appeared to be covered with a "bloom" which was lost after touching them. Opportunity to again examine them might disclose the phosphorescent phenomena for which these forms are celebrated in mines, a fact not known to me at the time of their original collection. The species occurs in no other part of the cave.

At numerous localities, where there is some moisture, occurring on dead specimens of *Hadenœcus subterranea*, the so-called "cave cricket," is *Isaria* (*Sporotrichum*) *densa* Link. This fungus is one of the most beautiful when growing in suitable stations, the mass appearing as a flocculent bunch of cotton clinging to the walls or lying on the damp earth. I have found the form in many localities, but most abundantly in El Ghor and along River Hall. Associated with it is the yellow form to which the name of *Isaria* (*Sporotrichum*) *flavissimum* Link has been given. But the yellowish form grows less luxuriantly and is found on other decaying matter, while the first named occurred to me only on dead *Hadenœcus*.

A number of moulds and other low forms have been collected by me at different times, and been studied by Dr. Thaxter, of

Harvard University, to whom I am indebted for their determination. Among them are *Microascus longirostris* Zukal, *Zasmidium cellare* Fr., *Gymnoascus setosus* Eidam, *Gymnoascus uncinatus* Eidam, and several others that were indeterminate. There were collected also a probably new *Cœmansia* and *Papulospora*, a new *Bouderia* and two "apparently new species of *Gymnoascus*." It will be observed at once that many of these forms are well known ones, and in explanation of that fact it is sufficient to say that all came from the great hall beyond the Echo River, which is called Washington Hall, and which is the favorite lunch-station of parties on the "long route." On the debris of the lunches, on the chicken bones and half-filled egg shells, occurs a wealth of these minute forms. It would seem to be quite clear that they are introduced to this part of the cavern with lunches. Their internal distribution is mainly effected by means of the "cave rat," *Neotoma magister* Baird, which is abundant at this locality. These animals drag the bones and other remains of lunches to great distances, and the spores of the fungi are correspondingly widely distributed.

One of the most characteristic and marked forms that the casual visitor will notice is the widely spreading patches of snow-white fungus which covers the boards of bridges and hangs in beautiful festoons from timbers, or which spreads over a large area of wet earth from some water-soaked board as a center, especially in the Labyrinth and in River Hall. This is *Mucor mucedo* Linnæus, and is quite abundant. I have seen patches extending from an old timber that covered two square yards and others which quite covered the walls in some favored places. This plant is the most conspicuous fungus in the cavern. The others must be looked for especially to be seen.

At two places in the cave occurs a very abnormal species of *Fomes* (*Polyporus*) *applanatus* Pers., which is certainly introduced from the outside on the timbers on which it is found. The original form is illustrated by specimens which, on comparing it with the cave specimen, one may note the wide divergence from the typical form. Dr. Charles H. Peck says of this specimen: "It is, of course, very imperfectly developed, having no hymenium, as is usual when it grows in damp, dark places, as

in caves, old mines, wells, etc. I have specimens from the coal mines of Pennsylvania in which the growth is much larger than this. I suspect it is an effort on the part of the plant to get to the light, and instead of the usual sessile pileus it makes an elongated stem-like growth. It grows on wood; and it is possible, in some cases at least, that the wood may contain the mycelium when it is carried into the cave or mine."

This great difference of form, in the light of the suggestion of Dr. Peck, is one of the most interesting botanical facts of the cave. The specimens, when fresh, had, at the reddish tip, a white, powdery bloom that gave a bleached appearance to the last inch or more of the specimen. It was found growing in a damp station not far from the Bottomless Pit.

These main new facts in the occurrence and distribution of cave insects and plants have been presented as a contribution to a knowledge of the life of the most interesting cave on the continent. Its great expanse renders likely additional discoveries on complete study.

METHODS IN ECONOMIC ORNITHOLOGY, WITH SPECIAL REFERENCE TO THE CATBIRD.

By Sylvester D. Judd.

The determination of the food habits of birds is of vast importance in rural economy. Owing to the ignorance on this subject, such a grave mistake as the introduction of the English sparrow was made. In order to ascertain the food of any bird, and to determine its relation to agriculture, a definite scheme of investigation must be followed. Until recently the method employed was that of observing birds while feeding; but this gave such fragmentary knowledge that distorted conclusions were drawn, and many innocent birds suffered, particularly the hawks and owls, until Dr. A. K. Fisher,[1] by the careful examination of stomachs, showed that of the 49 species of our hawks and owls, only 6 are injurious to agriculture.

[1] Hawks and Owls of the United States, Bull. 3, U. S. Dept. Agriculture.

The method of field work, which requires the united efforts of a botanist as well as an entomologist, yields results which must not be considered a final solution to the problem, but only a contribution to our knowledge. Nevertheless, field work is indispensable, since many interesting facts may be learned by going to fruiting trees or shrubs and watching the birds that visit them. This sort of work can be done to a limited extent in a field where grasshoppers are abundant; but with small insects this method of observation is almost impossible. Even if all the different kinds of food eaten could be ascertained in the field, the result would still be unsatisfactory, for the proportions of the various constituents would be unknown, consequently any economic conclusions would be impossible. The examination of the contents of the stomach is the "court of final appeal,"[2] because here the proportions of the different elements of the food can be determined. In researches in economic ornithology, under the direction of Dr. C. Hart Merriam of the U. S. Department of Agriculture, I have examined the stomachs of some 200 catbirds, and found that about half of this bird's food is fruit, while the other half is insects. Beetles and ants form the most conspicuous part of the insect food, and grasshoppers and smooth caterpillars rank next in importance, while spiders, myriapods and bugs are frequently eaten.

Although this method of stomach examination shows conclusively what has been eaten, it neither tells what has been refused nor does it give the preferences of a bird for one kind of food over an other. The reason for this is that the different elements of the food supply where the stomachs were collected is unknown. To obtain such a knowledge of the accessible food supply, and to learn just what insects and berries the birds had an opportunity of eating, I took an excursion on July 30, 1895, to one of the many gullies which intersect the bluff overlooking the estuary of the Potomac, to make observations on the feeding habits of the catbirds, and to collect data and material of the available food supply. The particular gully chosen was about eighty yards wide by twice as long,

[2] Prof. F. E. L Beal.

and extended back at right angles to the river until it rose to the level of the bluff. On the slanting sides of this depression a belt of catbriars (*Smilax*) afforded excellent cover for catbirds. Just above the catbriars and concentric to them was a belt of locust trees. The part of the gully next the river was swampy and supported a forest of willows, while the upper part was drier and afforded an abundance of ripe elder and blackberries upon which birds were seen feeding. The catbirds seemed to devote most of their time to berrying, though some were seen way up in the tops of the locusts, which had been browned as by fire by the locust leaf miners (larvæ of *Odontota dorsalis*), the adult beetles of which were swarming in myriads over the leaves. Several catbirds sang sweetly in the sassafras trees, which were sparingly intermixed with the locusts, while others were seen hopping on the ground where they had a chance to pick up grasshoppers, millers or ants. In all, 15 catbirds were seen in the little gully, and 13 of these were shot. Their entire digestive tracts were examined ; 9 of them contained the destructive locust beetle, 18 of these orange and black pests having been taken from one bird. This is surprising, because beetles of this family (*Chrysomellidæ*) secrete a substance which is supposed to be distasteful to birds. Every one of the birds had eaten elderberries, and all but two blackberries. Five of the 13 had taken sassafras berries, and 3 wild cherries. Both of these fruits were bright green and very hard. The eating of such apparently unsavory fruit, when there was a plenty of luscious blackberries seems, to say the least, a whim of aviam epicurianism. In the insect food of these birds there were no ants or grasshoppers, but, on the other hand, the supposedly distasteful locust leaf mining beetles. The countless number of these beetles, and consequently the ease of obtaining them, seems to be the only circumstance to account for the rejection of such favorite food as ants and grasshoppers. Not one of the false caterpillars (*Tenthredinidæ*) that were observed stripping the cornel bushes under the willows was to be found in the catbirds, thus showing that these larvæ are not eaten when the locust beetles are obtainable. From the knowledge gained by the study in this little

gully, one would, with a fair degree of accuracy, be able to predict what kind of food catbirds would eat in another gully that had absolutely the same food supply. And so one might perfect this line of research until he could tell just which of the objects a, b, c, d, e, f, g, h in the accessible food supply of a locality a given bird would select.

Let this suffice for the combination of the field work method with that of the examination of stomach contents. Very often birds that are too shy to be watched in the field may be kept in captivity and then offered various kinds of food. Such experimentation has proved a profitable adjunct to stomach examinations. Among the birds that I have experimented with were four catbirds, which had been recently trapped in the vicinity of Washington, D. C. Among the first insects offered to my birds were a dozen spiny black caterpillars (*Euvanessa antiopa*). The birds, though hungry, refused these repulsive looking creatures. By the next morning the caterpillars that had crawled out of the cage had pupated. I put one of these pupæ on the floor of the cage. It was eyed for some moments by a hungry bird and then devoured. Several days later the pupæ hatched into the brown butterfly which is so common in early spring, and one of these having been given to the birds, they fought over it and each finally obtained part of the insect. Beetles and ants were next tried. In order to prevent them from escaping from the cage, they were put on a piece of cork, which was anchored in a large drinking bowl. The birds soon became accustomed to the cork island with its cargo, and when all the insects had been eaten, often rapped on the cork for more. Bad smelling beetles (*Carabidæ*), which have been supposed to develop their stench to protect them from birds, were snatched as soon as they were put on the cork. Ants, which are highly flavored owing to the large quantity of formic acid which they contain, seemed te be regarded as choice food. Stink bugs (*Pentatomidæ*), whose nauseating odor is familiar to every one who has been berrying, were eaten by the catbirds, even when they had been well fed with other food. Large hard shelled beetles, such as *Passalus cornutus*, were refused by the catbirds, but soft insects, such as

grasshoppers, spiders and smooth caterpillars were greedily devoured. Plant lice were not eaten, but the ants which tended them were quickly disposed of.

In making experiments with stinging *Hymenoptera*, I found that my catbirds refused to take honey bees; but a chewink ate one of these insects and died within fifteen minutes. Kingbirds, as a rule, eat only drone bees, but an instance is recorded of a bird that was found with a bee's sting implanted in its tongue. My catbirds regarded slugs (*Gasteropods*) as unsavory, but ate small snails. The birds relished thousand legs and earthworms.

By experiment it was demonstrated that beetle larvæ are regarded as dainty tidbits, but, owing to the fact that they live in such secure places as under sod or in rotten wood, they are seldom found by the catbirds, who has not the bill of the woodpecker to chisel them out, nor the sagacity of the grackle in following the plow.

Having ascertained what insects were eaten by caged catbirds, it will now be instructive to compare the results obtained by experiment with those arrived at by stomach examinations. Beetles formed, in the 200 catbird stomachs examined, the most important part of the animal food, and among these beetles strong scented *Carabidæ* were found oftener than any others. This family is very numerous in individuals, and consequently its members would be the insects which the catbird would most often have an opportunity of picking up. It was first supposed that they were eaten because of the ease of obtaining them and in spite of their offensive smell, until experiment demonstrated that catbirds regard *Carabidæ* as very palatable articles of food. None of the hard shelled beetles, which were refused by captive catbirds, were detected during stomach examinations; on the other hand, such soft animals as spiders and grasshoppers were found in large quantities, thus further showing the coincidence between the results of experiment and stomach examination. Both methods of investigation show that ants are much relished, and that smooth caterpillars are preferred to hairy ones.

Beside experimenting with insects, a series of experiments was conducted with the hope of ascertaining what fruits are preferred by catbirds. Equal volumes of cherries and mulberries were placed on the cork island, and at other times the experiment was repeated with strawberries in place of the cherries, and invariably the mulberries were selected. When there were any hopes of getting mulberries, the birds never touched strawberries or cherries. In the next experiment red and white mulberries were both put into the cage; the birds always took the red ones first. This last experiment showed that catbirds can distinguish colors. The whole series of experiments showed mulberries are preferred to cherries or strawberries, hence it may be inferred that these two latter crops can be protected from catbirds by planting mulberries. This preference for mulberries could not be deduced from stomach examination alone, for the reason that mulberries are not common in many places where catbird stomachs were collected. Experiments with other fruits would have been performed, if my birds had not been killed by a cat.

In recapitulation I would say that in investigating the food of a bird, the first thing to be done is to examine enough stomachs to obtain a general idea of the bird's food. After this has been done, one can intelligently go into the field and watch birds feeding. The different kinds of available food should be noted before collecting stomachs, then it will be possible to ascertain what the bird will eat, its preferences, and what it will refuse.

DR. ALEX. GOETTE ON THE DEVELOPMENT OF THE VERTEBRAL COLUMN.

By O. P. Hay.

In "Zeitschrift für wissenschaftliche Zoologie," Vol. LXII, pp. 343–394, Dr. Alex. Goette has published a paper entitled "Ueber den Wirbelbau bei den Reptilien und einigen anderen

Wirbelthieren." In this paper, besides detailing the results of his studies on certain lizards, the author considers views held or supposed to be held by Dr. E. D. Cope, Dr. G. Baur, and myself concerning the morphogeny of the vertebral column. In the present paper I shall endeavor to vindicate the position I have taken on the subject. Drs. Cope and Baur are capable of making their own defense.

My conclusions regarding the mode of development of the vertebral column were reached after a careful study of the young of Amia and a comparison of the results with the vertebral structures of other animals, living and extinct. These conclusions were set forth in "Publications of Field Columbian Museum," Vol. I, pp. 1–54; and it is to this paper that my distinguished critic refers. That paper really consists of two parts; the first part dealing with the structures of the adult axial skeleton, the second, beginning with page 25, treating of the development of the vertebral column in the young fish. The views expressed in the first part are somewhat modified in the second.

It may be well first of all to correct some errors into which Dr. Goette has fallen regarding statements made by myself. On page 381 of his paper he affirms that I found in the embryo of Amia, between the bases of the arches and the notochord, a dense layer of connective tissue, which later disappeared. I really found nothing of the kind, and I know of no expression in my paper which suggests it. A statement somewhat to this effect is, however, made by Dr. Gadow and Miss Abbott in "Phil. Trans. Roy. Soc. London," Vol. 186, p. 202; but there is no indication given that Goette had seen this publication.

On the same page of Goette's paper occurs the statement that I discovered that in dorsal region of Amia the upper intercalated cartilages push themselves under the succeeding dorsal arches, lift the latter away from contact with the notochord, and then fuse with them. Goette also refers to figure 10 of my paper as representing such a condition. The assertion indicates a complete misconception of both the text and the figure. What I said was that *at a very early period* these intercalated cartilages may have been fused with the arches. After they

have once become distinct they never again fuse with the arches, and my figure represents them as being entirely distinct.

It is also to be noted that I disclaim holding the view that the intervertebral menisci of the Amniota have anything to do with the degenerated hypocentra.

A considerable portion of Goette's essay is devoted to a defense of a publication by Dr. Ludwig Schmidt, on which I made some remarks. I am unable to find anything in my former paper to the effect that Amia calva, being the most recent fish of the group, cannot possibly retain the embolomerous structure in case this were the older. It requires only a cursory perusal of that paper to discover that, after a study of the young of Amia, I did not regard the embolomerous condition as more recent than the rhachitomous. I need here only to call attention to page 41 of that paper.

Furthermore, I leave it to unprejudiced readers to decide whether or not I did Dr. Schmidt injustice when I affirmed that he had given two irreconcilable explanations of the way in which the simple vertebræ of the dorsal region had resulted from the embolomerous condition of the tail. Schmidt's first effort is plainly directed toward showing that the dorsal vertebræ have originated through the direct union of two such disks as occur in the middle of the tail. He describes and figures an abnormal vertebra which had been produced by the fusion of a "centrum" and an "intercentrum." He figures a section of this vertebra and calls attention to the "rudimentary arch" of the "centrum" and to the double-cone-shaped cavity between the two disks. Then, referring to the dorsal vertebræ, he notes their close resemblance to the united disks of the tail, the presence of the rudimentary arch, and then endeavors to explain the absence of the notochordal cavity on the ground of the very early union of the elements. This is a procedure wholly without point, in case one of the elements has become wholly or almost wholly reduced. Dr. Baur had already suggested this very natural explanation, and the only fault that Schmidt found with Baur's idea was that the latter regarded

the "intercentrum" as the enlarged base of the lower arches, instead of a complete vertebral body.

From the consideration of the vertebræ of Amia from this point of view Schmidt turns to the discussion of its fossil relatives; and here he gives a different solution of the problem, the one that Goette endeavors to have us accept as the only one proposed by his pupil. The "intercentrum" is regarded as increasing at the expense of the "centrum," until in Megalurus and Amia the latter element is reduced to a mere vestige, the "rudimentary upper arch." The first method of union is that of two nearly equal elements, the latter the union of the lion and the lamb—with the lamb inside of the lion.

So far from being open to the charge of opposing the view that the dorsal vertebræ are constituted of elements homologous with those found in the somites of the tail, with reduction of some of them and expansion of others, that is the very pith of the embryological portion of my former paper.

I may remark here that in Amia the pleurocentral element can hardly be regarded as vestigial, since it appears to furnish the foundation for the upper half of the vertebral centrum. Not merely the small portion of the cartilage which is seen in front of the upper arch, but the whole of the cartilage in the upper half of the dorsal centrum, belongs to the pleurocentrum. The figures of Callopterus reproduced by Goette are very interesting, inasmuch as they show to what extent in that form the above element had become reduced. When the reduction becomes complete, the vertebral centrum becomes a hypocentrum, a condition affirmed by Cope to be that of the higher fishes in general.

Aside from any misunderstandings, there exist between Goette and myself certain differences which are fundamental. He holds that there is to be found in most vertebrates a specialized sheath which, composed of cells, surrounds the notochord and becomes segmented to form the "primary vertebral centra." This sheath, called in other publications "äussere oder zellige Chordascheide," is now named the "perichordal sheath." In some of Goette's writings it appears to be certain that he has in mind the elastica externa of other writers; in

other papers it is evident that he refers to a somewhat specialized layer of cells belonging to the skeletogenous tissue. According to Goette, the arches, upper and lower, are formed in the skeletogenous sheath outside of this perichordal sheath, and only later become applied to it. The primary vertebra thus consists of the arches, upper and lower, and the ring around the notochord. Furthermore, Goette contends that, primitively at least, two such vertebræ belong to each somite. In few or no animals do we find both vertebræ present in all their parts, but the author referred to finds vestiges of them in even the highest vertebrates. I cannot subscribe to these views.

Without desiring to detract in the least from the merits of Goette's embryological labors, I believe that I am not wrong in saying that the importance, even the existence, of this perichordal sheath has not been recognized by vertebrate embryologists. Most writers deny that the alleged sheath is anything more than a portion of the general skeletogenous layer and hold that it graduates into the latter. Hasse appears to come nearer than others in recognizing a special layer of the skeletogenous tissue; but his "innere Zellschicht" does not appear to correspond wholly with Goette's perichordal sheath, since the former invests also the spinal cord. Furthermore, Hasse finds his layer of cells in Acipenser, to which genus Goette has denied the perichordal sheath.

It is very apparent too that in one great group of vertebrates, the Elasmobranchs, Goette's theory of the origin of the primary vertebral body has been demonstrated to be erroneous. Instead of there being, in these fishes, an "äussere Chordascheide" which has arisen as a distinctly specialized layer of the cells of the skeletogenous tissue, and which is a little later cut off from the less modified portions of this tissue by the elastica externa, it has been demonstrated by Klaatsch and Gadow and Abbott that the layer of cells called by Goette "äussere Chordascheide", takes its origin from migrating cells which, starting from the bases of the arches, have pierced the elastica externa and made their way into the fibrous mass of the elastica interna. The "primary vertebral centrum" of the sharks must then be a

thing very different from what it is in the other groups of vertebrates.

Considering that the limits of the "äussere Chordascheide," its significance, and even its existence, are not yet agreed upon, the alleged product of its transformation, the "primary vertebral body" is a thing too intangible to be long considered in the presence of manifest realities.

Goette claims that in the tail of Amia the two disks belonging to each somite are two nearly equally developed vertebræ; it happening that only the arches of one of them are in a vestigial condition. I do not betieve that the elements which give rise to the two rings are equivalent. The arches, basidorsals and basiventrals of Gadow, arise at a later period than do the intercalated cartilages; at least they do so in Amia. The arches occupy a position essentially different from that of the intercalated elements, the former being placed intermyomerically, the latter myomerically. The arches have probably been evolved as a means for the fixed attachment for the muscular segments: the intercalated cartilages as a system of stop-gaps. Later these subordinate pieces have in many cases assumed a more important role.

I have been able to discover no reason for supposing that there is, in each somite of Amia, either one or two "primary vertebral centra." For, if by "perichordal sheath" Goette possibly refers to the elastica externa, this in Amia is certainly homologous with the structure so-called in the Teleost fishes and which, according to all recent observers, is not cellular. If by perichordal sheath Goette means a distinct layer of cells, which lies against the outside of the elastica externa and passes beneath the arches, then there is no such sheath. In my smallest specimens, 10 mm. long, a delicate layer of cells surrounds the notochord, but it does not show itself as a special layer under the bases of the arches, although the latter are not yet distinctly chondrified. Nor is there at any stage any such a well defined layer of tissue under the cartilages. Conversion of the arches into hyaline cartilage begins at a little distance away from the elastica, but when the process is completed, the cartilage comes into immediate contact with the elastica. Nor

is there any modified layer of cartilage next to the elastica. Furthermore, when ossification begins, the layer of bone does not pass between the base of the arch and the elastica, but over the sides of the arch and against the elastica from an upper arch to one below it and to its fellow piece.

For the original duplication of vertebræ Goette finds evidences in the Urodeles, lizards, etc., in what he regards as the occurrence of vestigial upper arches, transverse processes, and ribs. These, it seems to me, are as yet of too uncertain nature for us to base on them any such serious conclusions as does Dr. Goette. They are probably susceptible of being otherwise homologised. Goette has reproached the palæontologists for deriving their theories from their palæontological, rather than from embryological, studies. But, are the embryological materials any more to be relied upon to furnish safe conclusions than are the materials used by the palæontologist? Under the strata of what countless generations the primitive structures have been buried! How many elements that once were prominent and perhaps all-important have been totally suppressed, or if vestiges of them remain in the embryo, how difficult it is to detect and to interpret them! How many adaptive modifications have been introduced into perhaps every species! Among the embryologists themselves there are many who declare that ontogony offers little reliable evidence regarding phylogeny. This I am not ready to admit. The palæontologist must not despise the embryologist; nor must the latter scorn the former. We shall do well if we succeed in explaining nature after we have made use of all her aids.

As regards the duplication of ribs, a doctrine of Goette's, one set for each supposed vertebral centrum, one pair must, so far as I see, have fallen in the intermuscular septum, the other in the middle of the myomere. The latter is a condition unknown, hardly conceivable. Two ribs placed at different levels in the same intermuscular septum might belong easily to the same vertebral body, as in the case of many fishes. How fortunate it is that the shad has not inherited a full complement of vertebræ and their appendages!

Goette objects to the views entertained by Cope, Baur and myself, since they lead to the conclusion that the vertebræ are not homologous throughout the various groups of vertebrates. They do not need to be homologous and are not so. The vertebral centra of the sharks, arising as they do from the invasion of cells into the elastica interna, cannot be homologous with those of the Teleostomes, which originate in a skeletogenous tissue outside of the elastica externa. An abnormal vertebra of the tail of Amia formed by coalescence of the two disks of a somite, is not homologous with one of the disks, even if we were, with Goette, willing to regard the latter as vertebræ. Nor is a simple vertebra of the dorsal region, made up as it is of parts of two alleged vertebræ, homologous with anything that we find in the tail.

Of course, Goette holds that the " primary vertebral centrum" is found in all the Digitata, and is developed wholly independent of the arches. So far as the Amphibia are concerned, I believe that the centrum is primitively derived from the arches, even in the fossil Branchiosauridæ. We do not need to suppose that cartilage has, in all cases, surrounded the notochord where bone is now found. As in Amia, the ossification may spread from the bases of the arches into the soft connective tissue lying against the notochord. It may even be so precocious in its appearance as to suppress the cartilaginous stage of the arches, as is the case with many fishes.

I find that in the young Amia a thin layer of cartilage is formed under the bone of the centrum, lying close against the elastica. It appears to spread from the bases of the arches, and is developed later than the bone. Possibly the ancestors of Amia possessed a more exstensively developed condition of this cartilage.

A comparison of the early condition of the vertebral column of the Urodeles with that of Lepisosteus brought me to the conclusion that the intervertebral cartilages of both are homologous with the " intercalated cartilages " of Amia, and Dr. Gadow in a recent publication has adopted the same view. Without attempting to explain all of Hasse's and Field's results, I believe that they are entirely in error when they affirm that

the earliest rudiment of the vertebral centrum is a segment of the elastica externa, and that the cells of the skeletogenous tissue which develop into the intervertebral cartilages first make their way through the elastica. Whatever that earliest rudiment may be, it has nothing to do with the elastica externa. This is present, as it is in fishes, in close relation with the elastica interna. In the tail of young Necturus, where the bone is already well developed, the externa may be plainly seen as a highly refractive line between the interna and the centrum. But this is nothing new, since other observers have seen the externa distinct from the centrum.

As regards the lizards and other Amniota, I am willing to concede that there intervenes between the bases of the arches and the sheath of the notochord a distinct cartilage on which rest the bases of the upper arches. Goette's "primary vertebral centrum" found in the lizards I regard as the pleurocentrum, which has been pushed under the bases of the arches. If it is such, we might expect to find it starting in its development on the upper side of the notochord; and Goette's figure shows at least that it is thinner on the lower side than elsewhere. I am ready to admit that in the Amniota the basalia, to use Gadow's terms, have formed unions with the interbasals behind them, instead of with those in front of them. The possibility of this was considered in my former paper, p. 51. Consequently, in the vertebra figured by Goette Figs. 1, 2, 7, the centrum has been pushed forward under the arch in front of it. It is quite possible that its original myomeral position is no longer reproduced in the embryo.

If our minds can once be freed from the idea of a primary centrum we shall probably find little reason for disagreement about the development of the vertebræ in the different groups. It seems to me beyond doubt that the rhachitomous vertebræ of the dorsal region of Eurycormus (Zittel, Handbuch, vol. 3, p. 230) must have been developed from the embolomerous vertebræ of the tail. We have seen how the rhachitomous vertebræ of the dorsal region of the young Amia unite to produce the definitive vertebræ. Thiollière's figures of Callopterus, reproduced by Goette, show us how, by the reduction of the

pleurocentrum, the vertebral body becomes a hypocentrum. If now the pleurocentrum should grow at the expense of all the other elements, we would have such a vertebra as Cope and others find in the Amniota. And considering what we find in the temnospondylous Stegocephali, in the Clepsydropidæ, and in Sphenodon, I cannot refuse to believe that such a course of development has been pursued.

It appears to me unnecessary to suppose that the embolomerous condition has at any time resulted from the rhachitomous. In some cases probably the latter has grown out of the former; but it is by no means a necessary course. Probably in most cases the lower intercalated cartilages have suffered reduction before coösification has united them with the upper intercalated pieces.

THE SEVENTH SESSION OF THE INTERNATIONAL GEOLOGICAL CONGRESS.

This will probably eclipse any previous session in many respects and will enjoy the distinction hitherto conceded to the second, or that of Bologna, of being the most notable concourse of geologists, and of making the most important contribution to geological knowledge, both practical and theoretical, in the history of this Congress. Many circumstances conspire to produce this result. In the first place Russians share with Americans the reputation of being lavish in expenditure and prodigal in hospitality; it may be added of both nations also, that this extravagance is not diminished because it furthers some important project.

When at the London session of 1888, it was decided to hold the fifth session of the Congress in Philadelphia in 1891, the geological world was prepared to be astounded at the profusion of the hospitality and the generosity exhibited in the general management and especially in the long excursions. That the bacillus of Officialism infected this egg before it was laid in the wrong nest, and broke hope's promise as to its hatching, only

has increased the zeal of the Russians to outdo their most dangerous rivals.

The next Congress was that of 1894 in Zürich, Switzerland, where there were rocks of the world's crust enough, but those of commercial value were not superabundant. While Switzerland did herself credit, therefore, nothing was done which deprived the Bologna Congress (1881) of the right to be considered the most successful and brilliant thus far held. The Russians thereupon secured the favor of the Tsar and of his Ministers and called to their aid all the official and other geologists of the Empire.

The large cities and towns, the wealthy syndicates and proprietors, all united in the efforts to draw to Russia the largest possible number of scientific men, and to conduct them over the maximum of Russian territory in order that the resources of that enormous realm (or rather of its European part) might become known as they never have been known before.

By imperial decree the Consuls in all foreign countries have been notified to facilitate to the utmost degree the viséing of passports upon presentation of the card of membership of the Congress. This same card entitles the owner to gratuitous transportation over the entire system of Russian railways. It will also enable the possessor to pass his baggage and effects through the frontier, with the minimum amount of embarrassment from Custom House regulations. Finally objects marked for the Geological Congress may be sent without being opened at the frontier to St. Petersburg, and there opened in the presence of an officer of the Congress. The business to be transacted at the meeting of the Congress will be referred to hereafter. Equally important are the opportunities for the masters of the branch of science to meet each other and discuss face to face the problems which hitherto have been debated at long range and through the desultory and uncertain medium of scientific journals or comptes rendus in different languages, the illustrations and nomenclature of each party to the controversy being drawn from his own land.

But most instructive of all the customs has grown that of bringing the students from other lands face to face with the most

striking geological phenomena of the country where the Congress is held. To do this excursions are arranged and conducted by the best geologists of the nation acting as host and the foreign members are furnished with a "livret guide" or pamphlet containing maps, sections and a digest of the literature bearing upon the regions to be examined. This was done in Switzerland and the little book is one of the most valuable of the souvenirs of the Congress.

These Congresses have grown out of a resolution presented by the late Dr. T. Sterry Hunt in a meeting of the A. A. A. S. in Buffalo in 1876 to the following effect: "*Resolved,* That a Committee of the Association be appointed to consider the propriety of holding an International Congress of Geologists at Paris during the International Exhibition of 1878, for the purpose of getting together comparative collections, maps and sections, and for the settling of many obscure points relating to geological classification and nomenclature.[1]" The above Committee instead of "reporting on the advisability," etc., went to work, and with the assistance of numerous foreign members actually organized a central bureau in Paris, where the first Congress was held in 1878. After laying down the plan for future work, this Congress fixed the dues of membership at 12 francs, and created two Committees; one for the unification of the conventional geological symbols, and one for the unification of the nomenclature.

The next Congress was held in Bologna in 1881, and thanks to Prof. (now Senator) Capellini and his influence with the Italian Government, the most important progress up to the present time was made, and the proceedings were perpetuated in a volume which is a monument of good taste in typography and illustrations, and of scientific research in its contents. It decided to produce under the direction of the Congress a geological map of Europe, confiding its execution to Profs. Beyrich and Hauchecorne of Berlin.

The third Congress was held in Berlin in 1885, the year 1884 which would have been the next date for the Triennial

[1] About the same time and entirely independently, Prof. Giovanni Capillini made an almost identical proposition to certain influential geological friends.

Congress, having been allowed to pass without ono wing to the fear of the cholera which had invaded Southern France.

The fourth Congress was held in London in 1888, the fifth in Washington in 1891, and the sixth in Zürich, Switzerland, in 1894.

At the latter a special committee was appointed to select the topics which should occupy the attention of the members of the Congress. These topics have not yet been announced, but the reports of the committees on the unification of nomenclature, that of the committee on the production of a geological map of Europe (of which several parts have been issued since the Zürich Congress), and the special committees appointed by the last Congress; one under Prince Roland Bonaparte, on glacial phenomena, another under Prof. Michel Levy on petrography, and a third under Emm. de Margerie on bibliography (which has issued a valuable volume) will furnish plenty of material to occupy the five days of the meeting from the 28th of August to the 4th of September.

Preceding the session three contemporaneous excursions will be made. One of about 350 miles from St. Petersburg into Finland, one a little shorter into Esthonia, and a long excursion of 2300 miles lasting twenty-eight days over a most interesting part of the Ural Mountains on the borders of Asia as far as Ekaterineburg on the sixtieth degree of east longitude (east of the entire continent of Africa and about on the meridian of Mauritius).

After the Congress another choice of excursions will be made from Moscow SE., S., or SW. through Southern Russia in Europe to Wladikavkaz, where the three parties reunited will pass over the military road crossing the great Caucasus, and after visiting Baku, Batoum and other places, and traversing the Black Sea to Kertch and Yalta dismiss at Sebastopol on October 5th. The longest of these attractive excursions will not be less than 2700 miles.

Such a stupendous scale of entertaining visiting geologists is without precedent, and if the war clouds of the Levant but disperse, a long stride will have been gained by western savants in an understanding of the geological enigmas of European Russia. PERSIFOR FRAZER.

THE PICTURES OF PROF. E. D. COPE IN THIS NUMBER.

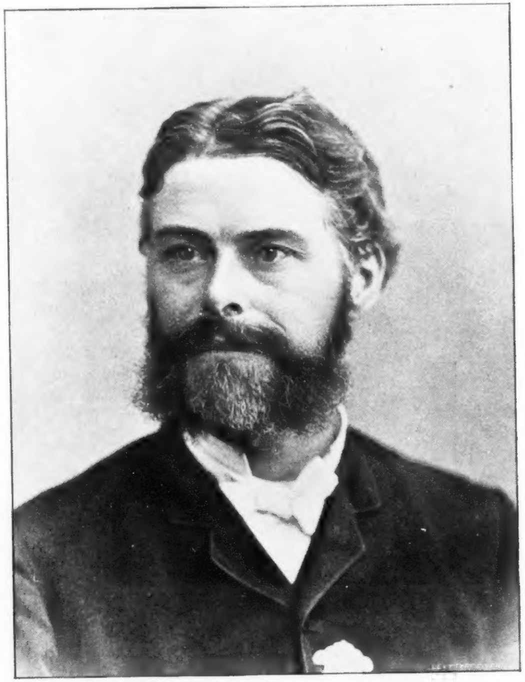
The picture which occupies the frontispiece of this number was painted by Mr. George W. Pettit of Philadelphia as a labor of love, and the study of the head of a remarkable man. Without at all compromising its accuracy as a portrait, Mr. Pettit has succeeded in imparting to it a great deal of the intellectual force which was familiar to all those who knew Prof. Cope intimately. As a representation of the man it illustrates the advantage which a faithful painting has over a photograph. The latter is an accurate reproduction of the object as it was at a given minute. All appearances have equal value during this short time; the accidental and transitory as well as the permanent and characteristic. Indeed some of the latter may and usually are masked by the former and possess less than their true significance in the resulting image. On the other hand the portrait by an artist is a composite of a great number of pictures preserved in his memory, in which the salient characteristics survive and the transient and adventitious expressions disappear.

This is well illustrated by the present portrait which was begun ten years ago or more, and has been so gradually evolved that it may be said to embody the essence of the original's aspect during that period. The beard is shown as it was worn during the greater part of the subject's life, and as most of his friends will remember it. During the last two years he had dispensed with it entirely as is manifest from the picture which has accompanied the greater number of the sketches of his life in newspapers and journals. This picture while pleasing in its expression, enforces what has been said of the advantage which a portrait study by an artist has over even the most agreeable photograph. The intellectual expression implying alertness and activity which is so manifest in the painting (as it was in the face of Prof. Cope himself) is in this photograph subordinated to a general expression of content and repose of all the faculties. The painting has been purchased for the American Philosophical Society, and will be added to those of the distinguished men which adorn its halls.

It should be added in justice to Mr. Pettit, that since the photograph was taken from which our illustration was made, he has improved his original work very notably, thanks to the suggestions of the relatives and personal friends who have viewed the painting, and to the inspiration due to his realizing the importance of his task. The late Russell Smith has also painted a portrait of Professor Cope which it is understood has been presented to the Academy of Natural Sciences.

The picture which follows is of a plaster bust of Prof. Cope by Mr. Eugène Castello of Philadelphia. It is naturally difficult to do justice to a statue in a half tone print, but it is easy to recognize in this work also the superior result which is obtained when a faithful artist interprets nature for the public. The expression, like that in the painting, is dignified and

1879



1884

1887

1892

thoughtful. Professor Cope gave five sittings for this bust from Nov., 1896 till January, 1897; and as Mr. Castello says "he assisted in the work of modelling by carefully indicating to me what he considered the characteristic points of his head from the position of an anatomist."

Like Mr. Pettit, Mr. Castello undertook this work "as a study artistically and personally," and found "opportunities of making himself familiar with the expressions of that unique face which have been valuable indeed."

The likenesses of Professor Edward D. Cope on the succeeding pages represent him at various times and probably in various moods during the last eighteen years. They are from photographs taken in the years indicated under the pictures; the earliest (1879) by Shew of San Francisco; those of 1884 and 1892 by W. Curtis Taylor; and that of 1889 by Scholl, both of Philadelphia.

These photographs are not all equally successful as pictures, but they represent the gradual change which has been taking place during the last period of his useful life in the vital force of one of the most persistent workers for science, and in this respect they will be of interest to those who know their subject only by name.

If it be asked why so many representations of Professor Cope are given in this, the first number of his journal issued since his death, the answer is that his temporary successor desires to make this, in so far as it is possible, a memorial number. But inasmuch as it would not be possible in so short a time to present a history worthy of the man and his work, only the superficial parts of such a history to wit: his appearance and the emotions which his death have inspired are here attempted. A proper necrological memoir of such a man cannot be prepared in haste, and should require the same painstaking care which its object bestowed on his investigations, for there is a useful lesson to learn from such a work, although one might judge from a remark which Professor Cope made to the writer a few days before his death that he was indifferent on the subject of a proper history of his life.

Being reminded of a promise he had made to the speaker many years ago to prepare a full autobiography, or notes from which a detailed account of his life could be written, he replied that he had published in a certain journal all that could be needed on the subject. A reference to the indicated publication resulted in finding four or five lines chiefly taken up with the statements of his birth, parentage and marriage. Fortunately for those of us who are proud of the achievements of the scientific man of the United States, the records of his career form part of his country's history. They are therefore carefully preserved and may be consulted by those whose interest or duty it is to use them.—P. F.

Edward Drinker Cope, the Editor-in-Chief and sole proprietor of this journal, died on Monday morning, April 12, 1897, shortly before 8 o'clock.

What this simple announcement means to the world of science we shall only begin to appreciate when the notices of his life in the scientific journals of Europe reach us, for highly as he was honored by some of the leaders of scientific thought in this country there is not so general an appreciation here as abroad of the services he has rendered to Natural History.

Those who were nearest to him, and who witnessed the growth of his own knowledge of a particular subject from the few isolated facts, with which his study began, to the complete development of his monographs, in which the object stood out from the rest of the productions of Nature, can best understand what qualities of the mind raised him to the pre-eminence which he honestly and easily won. These were quick, and accurate powers of observation and discrimination, a marvelous memory embracing the minutest details of what had been done in the same direction before, and tireless perseverance and industry amounting to a complete forgetfulness of self and neglect of mere personal comfort when in quest of accurate data. But the great world of readers and workers did not need this personal knowledge to judge of how he worked. It is scarcely credible that the monument which he has unconsciously reared to himself by his unceasing additions to human knowledge has been created in his short lifetime of fifty-six years, and the larger part of it in the face of difficulties which alone would have crushed any other man.

Nor was "species making" his only or even his chief contribution to the world's knowledge. With his power of instantaneously extracting from the well-filled treasury of his mind that group of facts which he needed, and his systematic inspection of the salient characters of an object, it was as easy for him to designate what was new to science in a mass of material just unpacked as for the ordinary naturalist to indicate the parts which were new to himself. In Cope's case the two were usually synonymous.

But his great and crowning faculty was that of recognizing the significance of each of his brilliant discoveries to the whole structure of science. His keenness in this, the highest manifestation of thought, was incomparable; and though his generalizations were often startling, they were never made rashly, and they have usually secured the acceptance of a steadily increasing body of scientific men.

Nor was it alone in the natural or biological sciences that he left the impress of his thought. Psychical phenomena, which are as far as possible removed from zoology and paleontology, enlisted a large part of his interest. Singularly enough for one who dealt so much in the concrete, his tendency was strongly towards idealism and against materialism.

He possessed definite views on all subjects, from metaphysics to politics, and was hopeful and optimistic in all. No amount of discouragement would prevent him from striving and hoping. He always saw a gleam of promise ahead that things would change, no matter how hopeless they seemed to others.

His power of dissociating his personal feelings from his actions on a given subject was so remarkable as to be almost unique.

This ethical side of his character was not generally understood, though his principles were always frankly announced and rigorously followed. No amount of personal liking or repugnance would change his vote on a question which ought to be decided by the qualifications of an individual or the propriety of a course of action, the sole points considered by him were fitness and justice.

Their most devoted friends were not fairer in estimating the true value of those whom Cope considered his bitterest opponents than he. His views and convictions on all subjects were impersonal, and were raised far above the malarial atmosphere of jealousy and malice.

These lines are traced by one who has been for twenty-five years his intimate friend, as a spontaneous tribute to a great master in science at the moment of his death, and may strike a responsive chord in the hearts of those who enjoyed the privilege of close acquaintance with Edward Drinker Cope.

April 12, 1897. PERSIFOR FRAZER.

western territory probably unequalled in extent and in variety. To this he was constantly adding by purchase from other parts of the world. Another result was an unparalleled series of papers from the pamphlet of three or four pages up to his huge quarto "Tertiary Vertebrates," and what was the more remarkable about this whole series was that the whole of these contributions to science were entirely his own work. He had no patience with the view that it is honest, that it is honorable, to hire others to do intellectual work, and that when payment is made for these services all title to the labor passes. Another characteristic of these same papers lies in this: that whether we have before us a hasty preliminary or a well-matured volume we are not in doubts as to what the author had before him. He at once seized upon the saliant and diagnostic features of his specimen, and described it clearly and intelligibly. There were no slovenly descriptions which might cover a dozen different things, and which might later be invoked in a dispute over a question of priority, and be made to fit the most desirable form.

It is not yet time to summarize all of these geological discoveries, to discuss the attempts to correllate the strata of the West with those of the Old World, to enumerate all the lines of descent worked out; but we may be pardoned if we mention a few, which, at the moment of writing, come to mind as of great interest. Here should be mentioned the reptilian giants Camarasaurus and Clidastes; Anaptomorphus, recently brought into such prominence in connection with Hubrecht's views upon the origin of the Primates; Phenacodus, the central stem of the higher mammals; the classification of the Theromorphous Reptilia, and the recognition of this group as the diverging point of Reptilia and Mammalia. This list might be easily extended almost indefinitely, as will readily be seen when we recollect that Professor Cope described nearly a thousand species of fossil vertebrates, and that, with every description there was an accurate conception of the position and relationships of the form described.

In lines other than paleontological his work was of the greatest value. The purchase, some thirty years ago, of the Hyrtl collection of skeletons of fishes—embracing some six hundred specimens—opened the way for a study of the fish-like vertebrates such as no other man has made. As a result he issued in 1871 a classification of the fishes, based upon structural characters, not on external form, which has been the foundation of all subsequent work in this direction, and which is rapidly replacing the older and more artificial systems of Cuvier and of Günther.

Cope's classification of the fishes is the only one that can be used by the student of paleontology. Besides this central work Cope published numerous papers upon the fresh water fishes of North and South America, and, wherever he touched the subject, he left his mark.

In the Batrachia and the Reptilia his work was of the greatest value. His synopsis of the Batrachia, based as it is on the entire structure of these animals, will long remain a standard for the American student; but in studying this work one must remember that its foundations were laid in its broader features, when the author was but twenty-five years of age. His small pamphlet on the osteology of the Lacertilia is a mine of structural facts, while his studies of the snakes, structural and systematic, cannot be ignored.

In the Invertebrates, Cope did but little; but one must not forget his studies of cave faunæ and his papers on the myriapods.

There was another side to Professor Cope's scientific work, that which dealt with theories of evolution. Professor Cope maintained in his earliest essays that the principle of Natural Selection, the very basis of Darwinism, could not be invoked as a *causa vera* to account for the origin of species and of higher groups. It did not explain the origin of variations, but could only act after variations had been produced to perpetuate and preserve those most advantageous to the organism. The cause of variation must be sought elsewhere, and he rehabilitated for this purpose Lamarck's early principle of the effect of use and disuse of parts. In this way he became the founder of the school of Neo-Lamarckians, in which his efforts were ably seconded by others, notably by Hyatt and Packard. He remained, however, until his death, the foremost advocate and exponent of this distinctively American school of philosophical biology.

His work in this line was not experimental, but rested rather on the evidence presented by fossil forms. In this way he could bring to his support a wealth of facts, accessible to no one else. His mechanical explanations were thoroughly and carefully worked out, and his views, like those expressed in his able paper on the homologies and origin of the types of molar teeth, were so cogently expressed that they made numerous converts to his theories.

This neo-Lamarckian view was first set forth in 1868, and was supported by numerous subsidiary theories advanced then and at later dates. Among them were the theory of "acceleration and retardation," the principle of "exact parallelism" so strikingly exemplified in the Anurous Batrachia, "homologous groups" and "consciousness in evolution." Later he turned to those more difficult evolutionary problems

—the origin of intelligence, the evolution of the ethical side of man, etc.—and expressed his views thereon in a series of essays which have attracted wide attention. These evolutionary essays were collected in a volume issued in 1887 under the title "The Origin of the Fittest." Later still (1896) these essays, together with his later contributions to the theory of descent, were summarized in a volume, "The Primary Factors of Organic Evolution;" a volume which several followers of Weismann have recognized as the ablest expression of anti-Weismannian views.

Scientific organizations the world over have expressed their appreciation of the attainments of Professor Cope. He has been elected an honorary or a corresponding member of many societies. In 1872 he was elected a member of the National Academy of Science; in 1879 the Royal Geological Society of Great Britain bestowed upon him the Bigsby gold medal, in recognition of his labors in the advancement of paleontological knowledge. In 1883 he was elected vice-president of the Biological Section of the American Association for the Advancement of Science, and in 1896 he was elected to the presidency of the same organization. In 1886, at the celebration of the four hundredth anniversary of the foundation of the University of Heidelberg, he received the honorary degree of Doctor of Philosophy, the highest honor the University could bestow. In 1889 he was elected Professor of Geology and Mineralogy in the University of Pennsylvania, and he held this position at the time of his death. He became the owner of THE AMERICAN NATURALIST in 1877, and since that time has been the senior editor of the magazine.

Professor Cope was a man of quick decision and of strong convictions. He did not believe in temporizing or acting from motives of policy. There were with him only two conclusions: a thing was either right or wrong, and when his decision was made, his course was clear. Compromise was foreign to his nature. These facts readily explain many things in his history. Personally he was a delightful companion. Gifted with facility and felicity of speech, and with experiences far beyond the run of the ordinary man, an hour in his presence was an hour not easily to be forgotten. How he enjoyed telling of his adventures and his battles; and if the joke were against him, its narration afforded him the more pleasure. Those who have heard him tell of the purchase of the skin of the long-tailed cat in Oregon will never forget the story.

Then how helpful he was. The treasures of his collection and the greater treasures of his intellect were open freely to all. If it would aid a fellow student or would solve a question, his most valuable specimens,

even those as yet undescribed, were freely offered, and their bearings fully explained; a helpfulness often acknowledged by most of his fellow paleontologists in their published papers, and all the more noticeable from its rarity in other quarters.

Another characteristic of Professor Cope was his readiness to admit a mistake or to correct an error when shown the truth. Instances of this are numerous. In the pages of this journal, to cite a single example, he severely criticised the late H. B. Pollard, for his theory that the Batrachia had arisen from the Crossopterygian Ganoids. Scarce a year later he accepted the same view, and advocated it in his later publications.

He was a most indefatigable student, and his capacity for work was astonishing. His house was his workshop, and his collections fairly crowded the family out, so that they had to seek other quarters. Everywhere there were either books or specimens. The cellar was filled with alcoholic collections, the upper floor with skins and skeletons, while the other floors were almost solidly filled with fossils. Some years ago his mammalian fossils passed into the possession of the American Museum of Natural History, in New York City. At the time of his death he was engaged in working up the fossils found in the Port Kennedy bone cave.

Professor Cope was married to Annie, the daughter of Richard Pym, who, with their daughter Julia, now the wife of William H. Collins, Professor of Astronomy in Haverford College, survive him.

J. S. Kingsley.

RECENT LITERATURE.

Surface Features, Missouri Geological Survey.—Charles R. Keyes, State Geologist, vol. X, 543 pages with 22 plates and 24 figures.

Clay Deposits, Missouri Geological Survey, Charles R. Keyes, State Geologist, vol. XI, 622 pages with 39 plates and 15 figures.

Volume X, contains a report on the Physical Features of Missouri by C. F. Marbut, one on the Formation of the Quaternary Deposits by J. E. Todd and a Bibliography of Missouri Geology by R. Keyes.

The report on Physical Features is the first work of the kind undertaken by any State Survey with the view of covering the entire commonwealth. The different surface features are described and their origin traced by the application of the principles of physiography.

A broad gently undulating upland plain forms the most conspicuous feature of the surface. It is divisible into the Prairie region and

the Ozark region. The former has an elevation ranging from 800 feet along the Mississippi to 1200 feet in the northwestern corner of the state. The Ozark region originates in a centre distinct from the Prairie district of elevation. It forms a large part of southern Missouri and portions of adjoining states with a maximum elevation within the former of 1700 feet.

The upland plain is broken by a number of escarpments formed by outcropping edges of hard strata underlain by softer rock. A number of these escarpments are described and the more pronounced are shown on a sketch map. Between successive escarpments lie platforms or belts each with their peculiar surface features depending on the character of the underlying rocks. The report concludes with an excellent account of the development of the streams, the subject of river meanderings receiving special attention.

In the report on the formation of the Quaternary deposits the author gives the distribution and limits of the surface formations of Missouri. The general character and relations of the several classes are thoroughly described. The quaternary deposits of the state are divided into (1) the Bowlder Drift, (2) the Loess and Gray Loamy Clay, (3) Terrace Deposits, (4) Alluvium. The characteristics of each class are clearly set forth and their limits shown on a sketch map. As the drift does not extend beyond the Missouri river the formations treated in the report lie almost wholly north of that stream. The report concludes with a summary of the quaternary history of Missouri.

The Bibliography of Missouri Geology is very full and complete, the plan being that of a dictionary catalogue or bibliographic index. There are included an author's list, a title index and subject entries and cross references. The advantage of this plan is that it is unnecessary to turn back from one title to another to obtain a full bibliographic reference.

Volume XI, is devoted entirely to a report on the clays of Missouri by H. A. Wheeler. Such thorough and complete treatment of its clays has never been undertaken by any state. The physical and chemical properties of clays receive especially full treatment. Thus considerable space is devoted to the subject of the plasticity, fusibility and shrinkage of clays, one chapter being devoted to each. A microscopic study of the clays was also undertaken with interesting results. A surprising variety of deposits are found throughout the state. Each variety is treated separately and its physical and chemical properties, distribution and adaptability to particular uses described. A chapter that will prove of much practical value is the one devoted to the tests and analyses of clays. Not only are the analyses of Missouri samples

given but also a very complete list of analyses of American and foreign clays. The report concludes with a brief working bibliography.

Both volumes are illustrated with many full page half tones and present a fine appearance.—A. G. L.

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General Notes.

PETROGRAPHY.[1]

Petrography of the Bearpaw Mountains, Montana.—A second paper[2] by Weed and Pirsson[3] on the rocks of the Bearpaw Mountains describes several intrusive masses in this mountain group, a leucite-lava from Bearpaw Peak and a series of the dyke rocks occurring so abundantly throughout the region. One of the intrusive masses is just north of Wind Butte. It consists of an augite-syenite composed of ægirite-augite, microperthite and a few accessories, among which is sodalite. At the post-office of Lloyd is an intrusive mass of trachyte, that has altered the argillites through which it cuts. The rock consists of orthoclase phenocrysts in an aggregate of feldspar, hornblende, augite in two generations and biotite in two generations. The Structure of this groundmass is allotriomorphic, hence the rock is as closely allied to the syenite-porphyries as it is to the trachytes. Another intrusion near the trachyte is a nephelite-basalt containing biotite and sodalite. The highest point of the mountains, Bearpaw Peak, is composed of leucite-basalt lavas, breccias and tuffs. In the midst of these rocks is an intercalated flow of leucitite, in which occur phenocrysts of biotite, augite and leucite in a groundmass of the thickly crowded leucites in a glass base. An analysis of the rock gives the following result:

SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	H_2O	TiO_2	Cl	P_2O_5	NiO	MnO	BaO	SrO	Total
46.51	11.86	7.59	4.39	4.73	7.41	2.39	8.71	3.55	.83	.04	.80	.04	.22	.50	.16	=99.73

The dykes of the region comprise syenite porphyries, leucite basalts, tinguaites and minettes. The tinguaites are mainly porphyritic rocks, but their phenocrysts are limited to the interiors of the dyke-masses, being absent near the peripheries. A tingauite porphyry from near Wind Butte is composed of aegirite, augite, alkali-feldspars, nepheline, cancrinite and small quantities of apatite, sodalite and fibrous hornblende. The pyroxenes present are made up of cores of an aggregate of colorless augites, surrounded by alternate zones of ægerite and augite. The large sanidine phenocrysts in the rock are surrounded by mantles of ægerine prisms, lying parallel to the banding planes of the feldspars.

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2] Cf. American Naturalist, 1896, p. 741.

[3] Amer. Jour. Sci., Vol. II, 1896, p. 136 and 188.

This fact, together with the absence of phenocrysts near the peripheries of the dyke indicates to the author that the large feldspars are not of intratelluric origin, but that, on the contrary, they were formed in place. The paper closes with descriptions of a quartz tinguaite-porphyry and several pseudoleucite-sodalite-tinguaites.

Rocks of the Laurentian area north of Montreal.—Adams[4] has examined carefully the geology of the Southern portion of the Archean protaxis of North America that lies in the western portion of the Province of Quebec. The rocks occurring in the area studied belong to the Grenville series and to the Fundamental gneiss. The former are present in a series of bands of alternating gneisses, quarzites, limestones and anorthosites, with occasional bands of pyroxene amphibolites, pyroxene gneisses, etc. All these rocks have been described[5] in other papers, but not as fully as they are described in this one.

The Rocks of the Leucite Hills.—Kemp[6] describes the Leucite Hills in southwestern Wyoming as the remains of a volcanic crater formed in later Tertiary time. These hills and several of the buttes in their vicinity are composed of flows of what was once a very fluid lava followed by upwellings of a more viscous magma. The rocks of the different flows vary in character. Some are extremely rich in leucite. In others sanidine replaces this mineral, and in specimens obtained from Black Rock butte phenocrysts of augite and olivine are plentiful. The rocks in which leucite is most abundant consist almost exclusively of this mineral and biotite. In the feldspathic rocks the quantity of leucite decreases as the sanidine increases. Augite is also present in these varieties sometimes as inclusions in the sanidine and at other times as large colorless crystals surrounded by rims of biotite. The rock of Pilot Butte, about 22 miles southwestern of the Leucite Hills, consists of large colorless crystals of augite and plates of light brown mica in a groundmass composed of a felt of augite microlites and a few leucites in a glass matrix. It is evidently closely related to the leucite rocks (leucite-phonolites) though mineralogically an augitite.

The Rocks of the Columbretes, Spain.—The rocks forming the little group of islands off the east coast of Spain, known as the Columbretes, are trachytes, trachytic-phonolites, tephritic trachytes, basalts and palagonite tuffs according to Becke.[7] The feldspar of the tra-

[4] Geological Survey of Canada. Ann. Rep., Vol. VIII. Pt. J.

[5] American Naturalist. 1897, p. 564, 1896, p. 300 and 579.

[6] Bull. Geol. Soc. Amer., Vol. 8, 1897, p. 169.

[7] Min u. Petrog. Mitth., XVI, p. 157 and 308.

chytes is sanidine mixed with a plagioclase rich in calcium. The hornblende is a yellowish-brown basaltic variety with a positive angle *c* v *C*, the only instance of a basaltic hornblende with this orientation. The different phases of the trachyte vary in composition as noted below and in structure. The basalts and tuffs present no unusual features. The rocks offer a good illustration of a petrographical province, the basalts representing the most basic members and the phonolites the most acid ones. The tephritic trachytes, with their small percentage of leucite are intermediate rocks. Analyses of the phonolitic (I) and the tephritic (II) trachytes and of the basalt (III) follows:

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	H_2O	P_2O_5	SO_3	CO_2	Cl	Total
I.	55.93	.42	21.83	3.62	.34	.61	2.54	7.84	6.01	.72	.22	.08	.03	.51	= 101.17
II.	53.12	.25	20.48	5.13	1.50	1.88	4.29	6.20	4.88	2.25	.43	.14		.28	= 100.59
III.	47.54	tr	17.70	5.19	6.20	5.94	9.12	4.01	1.43	.72	.62	tr	.10	.07	= 98.64

The chemical relations of these rocks to one another are represented graphically by means of a triangle whose angles represent 100 per cent. each of Na, Ca and K. The discussion upon which this method of representation is based cannot be entered upon in this place.

The dykes associated with the tonalite of Meran in the Tyrol.—Grubenmann[8] gives brief descriptions of the dyke rocks connected with the tonalites near Meran. These are quartz-mica porphrites, tonalite-porphyrites, tonalite-pegmatites, diabases and hornblende-kersantites. The pegmatites consist of plagioclase, microcline, quartz and muscovite. Where in contact with gneiss, this rock has developed in it andalusite and garnet.

Petrographical Notes.—The correctness of the analyses of the granular rock of Rongstock in the Bohemian Mittelgebirge having been called into question by Lang a new analysis has been recent published by Hibsch.[9] The results of this confirm the analysis first published.

Lyons[10] has analyzed a large number of specimens of the soils originating from the decomposition of Hawaiian lavas, and a series of the lavas from which they were derived. The results show that in the incipient weathering of the lavas there is a loss of silica, titanic acid, manganese, soda, potash and copper. The quantity of calcium present remains unchanged, while the percentage of magnesia increases. Upon further alteration magnesium, calcium and phosphoric acid are almost

[8] Ib., XVI, p. 185.
[9] Ib., XV, p. 487.
[10] Amer. Jour. Sci., Vol. II, 1896, p. 421.

completely lost. In the soils, however, there is a larger proportion of calcium and potassium present than in the 'rotted' lavas. This increase is ascribed to the action of plants and animals.

In an article in the Ponza Islands Schneider[11] describes the geological relation of the rhyolites, the trachytes, the pitchstones and the tuffs of the first two named rocks occurring there. His conclusions are questioned by Sabatini.[12]

BOTANY.[13]

New Species of Fungi from Various Localities.—(Continued from p. 343.)—HYPOXYLON VERNICOSUM E. & E. On dead wood. Sent from Ohio by Mr. A. P. Morgan as *Hypoxylon marginatum* (Schw.).

Stroma flattish-pulvinate, 2–3 x 1 cm. and 3–4 mm. thick, black and varnished outside and the uneven surface pitted all over by the papilliform ostiola, surrounded by an annular depression as in *H. marginatum.* Perithecia cylindrical, extending down nearly to the bottom of the stroma and about $\frac{1}{3}$ mm. diam. Asci cylindrical, 75–80 x 4μ, short stipitate, 8-spored. Sporidia oblong-elliptical, 6–7 x 3–3$\frac{1}{2}\mu$. Differs from *H. marginatum* (Schw.) in its varnished stroma and cylindrical perithecia.

PEZIZA (HUMARIA) TRACHYDERMA E. & E. On decaying wood partly buried in the soil, Valentine, Nebraska, May, 1896 (Rev. J. M. Bates, No. 416).

Sessile, shallow cup-shaped, 2–4 mm. diam., carnose, thinning to the acute, spreading margin, wood color when fresh, the furfuraceo-verrucose exterior remaining so when dry, but the hymenium becoming nearly liver color. Margin spreading when fresh, narrowly involute when dry. Asci cylindrical, 200 x 12–14μ, truncate above. Paraphyses thickened at the lips. Sporidia uniseriate, oblong-elliptical hyaline, smooth, 14–18 x 10–12μ.

Resembles somewhat a diminutive *Peziza vesiculosa*, but more open and shallower.

PHIALEA ARENICOLA E. & E. On sandy ground near "Blackbird Landing Bridge," Delaware, June, 1896 (Commons, No. 2784).

Stipitate, concave, becoming plane or even slightly convex, disk dull orange, 2–3 mm. broad, outside lighter, uneven, subpruiose. Stipe

[11] Min. u. Petrog. Mitth., XVI, p. 65.

[12] Ib., p. 530.

[13] Edited by Prof. C. E. Bessey, University of Nebraska, Lincoln, Nebraska.

stout, 2–4 mm. long, substriate, gradually enlarged above, same color as the disk. Asci narrow, linear, straight, short-stipitate, 60–65 x 4μ, paraphysate, 8-spored. Sporidia sub-biseriate, oblong, hyaline, continuous, 6–8 x 1½μ.

Differs from *P. epigaea* Karst. in its larger ascoma and much smaller sporidia.

TRICHOPEZIZA COARCTATA E. & E. On dead branches of *Vaccinium myrtilloides*, Mountains, Skamania Co., Wash., July, 1894 (Suksdorf, No. 507).

Scattered, superficial, sessile, hemispheric cup-shaped, smoky-white, 300–400μ diam., thin membranaceous, margin contracted quite strongly at first, so as to leave only a small, round opening, and fringed with short, fasciculate, smooth hairs about 25 or 30 x 2–2½μ. Asci clavate-oblong, 30–35 x 5–6μ. Sporidia biseriate, ovate, hyaline, 2-nucleate, 4–5½ x 2½–3μ.

Closely allied to *T. confusa* Sacc. (*T. punctiformis* Rehm.), but differs in its longer asci and different character of the hairs.

SCLERODERRIS ABIETINA E. & E. On bleached bark of fir trees, Newfoundland, September, 1896 (Waghorne, No. 61).

Erumpent-superficial, black, obconical, about ½ mm. diam., hymenium discoid or convex, areolate, with a very narrow, thin, almost obsolete margin. Asci clavate-oblong, sessile, rounded above, 70 x 15μ, 8-spored, overtopped by the filiform paraphyses. Sporidia fasciculate, clavate-cylindrical, multinucleate, becoming multiseptate, 50–65 x 3–4μ, hyaline.

HOLWAYA TILIACEA E. & E. On bark of dead *Tilia*, Canada (Macoun).

Ascomata gregarious or solitary, subcupulate, expanding to plane, thin (when dry), margin subundulate, 2–4 mm. across, black, with a short, thick stipe. Asci cylindrical, short-stipitate, 120–150 x 7–8μ. Paraphyses? Sporidia fasciculate or subbiseriate, narrow fusoid-cylindrical, nearly straight, multinucleate, hyaline, 40–62 x 3–3½μ.

Closely resembles outwardly *Bulgaria inquinans*. *Coryne ellisii* Berk. (*Stilbum magnum* Pk.) is found with this, and may be its conidial stage.

UROMYCES ROSICOLA E. & E. On leaves of *Rosa fendleri?* Crawford, Nebraska, June, 1896 (Rev. J. M. Bates, No. 438).

III. Sori hypophyllous, chestnut-brown, confluent over the entire lower face of the leaves, at first covered by the epidermis, soon naked. Spores globose or obovate, 20–35μ in the longer diam., epispore thick and coarsely tuberculose. Pedicels stout, about as long as the spores.

Puccinia sphaeralceae E. & E. I and III. On *Sphaeralcea angustifolia,* Mesilla, New Mexico (Prof. T. D. A. Cockerell).

I. *Aecidium sphaeralceae* E. & E., Bull. Torr. Bot. Club, August, 1895, p. 364.

III. Sori hypophyllous, minute, arranged in a circle, 2–4 mm. across, confluent, at first covered by the epidermis and pale chestnut color, soon naked and dark chestnut color. Teleutospores elliptical or oblong-elliptical, 30–35 x 19–22μ, nearly hyaline at first, becoming pale brown, slightly constricted at the septum, mostly regularly rounded and only slightly thickened at the apex, mostly also rounded below but often slightly narrowed at the base; epispore smooth. Pedicels stout, persistent, reaching 150μ long, hyaline.

Differs from *P. malvacearum* Mont. in the presence of an *Aecidium,* in its smaller, more obtuse and comparatively shorter teleutospores.

Aecidium sclerothecioides E. & E. On leaves of *Senecio lugens?* Golden, Colorado, May, 1896 (E. Bethel, No. 5).

Pseudoperidia amphigenous, subepidermal, buried in the substance of the leaf in pale yellowish, slightly swollen orbicular spots 2–4 mm. diam., slightly prominent in pustules ½ mm. across, at first closed, then irregularly open at the apex revealing the mass of reddish-brown spores which are globose 20–27μ, ovate 20–27 x 15μ, or subangular from compression; epispore smooth or nearly so, rather thick.

Differs from *A. sclerothecium* Speg. in its smaller, inseparable pseudoperidia.

Phyllosticta heucherae E. & E. On leaves of *Heuchera cylindrica* near Lake Waha, Idaho, June, 1896 (A. A. & E. G. Heller, No. 3265).

Perithecia amphigenous, hemispherical, suberumpent, broadly perforated above, 110μ diam., crowded in orbicular patches, ½–1 cm. diam. Sporules abundant, cylindrical, hyaline, 5–6 x 1–1¼μ.

Probably the spermoginal stage of some dothideaceous fungus.

Asteroma ivaecolum E. & E. On stems of *Iva xanthiifolia,* Denver, Colorado, September, 1896, E. Bethel, No. 28).

Fibrils feather-like, appressed, radiating, forming dark brown spots 2–3 cm. across. Perithecia seated on and among the fibrils, depressed-hemispherical 110–130μ diam., perforated above. Sporules oblong, hyaline, 4–6 x 1½–2μ.

Sphaeropsis celtidis E. & E. On dead limbs of *Celtis occidentalis,* Phillips Co., Kansas, 1896 (Bartholomew, No. 2348).

Perithecia gregarious or scattered, subseriate, about ⅓ mm. diam., covered by the epidermis which is slightly raised and barely pierced by

the conic-tuberculiform ostiolum. Sporules oblong-elliptical, brown, 18–21 x 8–10μ.

SPHAEROPSIS PHLEI E. & E. On bulbous base of dead culms of *Phleum pratense*, Newfield, N. J., December, 1896.

Perithecia densely gregarious, erumpent-superficial, black, ovate, about ¼ mm. diam., with a papilliform or sometimes conical ostiolum. Sporules oblong-elliptical, brown, 18–22 x 7–10μ.

PHLYCTAENA ALBOCINCTA E. & E. On dead stems of *Rhus toxicodendron radicans*, Newfield, N. J., September, 1896.

Perithecia buried in the bark, 400–700μ diam., the short ostiolum barely perforating the epidermis. Sporules linear, curved, narrowed and curved above, 12–15 x 1–1½μ. A horizontal section shows the perithecia surrounded by a white ring.

SCHIZOTHYRELLA BOREALIS Ell. & Sacc. On dry, decorticated (beech)? wood, Potsdam, N. Y., June, 1896.

Perithecia superficial, scattered or subseriate, orbicular or elliptical, ⅓–½ mm. diam., ovate-globose, at first with a papilliform ostiolum, soon broadly open and cup-shaped, glabrous, black. Sporules cylindrical, hyaline, occasionally dichotomous, separating into segments 6–15 x 1½–2μ, 1–3 septate.

Differs from *S. australis* Speg. in the dehiscence of the perithecia (not laciniate) and the shorter narrower sporules.

CYLINDROSPORIUM SPIRAEICOLUM E. & E. On leaves of *Spiraea betulifolia*, near Lake Waha, Idaho, June, 1896 (A. A. & E. G. Heller, No. 3303).

Acervuli innate, on small, light yellow, irregularly shaped spots 1–2 mm. diam., few (1–7) on a spot. Conidia clavate-cylindrical, straight, rounded and obtuse above, gradually attenuated below, 3–5 septate, 40–70 x 3½–5μ, hyaline, erumpent above in orange-yellow masses.

Differs from *C. filipendulae* Thüm. in its epiphyllous acervuli and larger clavate conidia.

MARSONIA CALIFORNICA E. & E. On leaves of *Juglans californica*, Santa Monica, California, August, 1896 (Prof. A. J. McClatchie).

Spots amphigenous, angular, 1–3 mm. diam., subconfluent, ferruginous becoming grayish above, border narrow, slightly raised, dark. Acervuli innate, visible on both sides of the leaf. Conidia cylindrical, mostly straight, but sometimes slightly curved, hyaline, uniseptate, 20–27 x 3μ, obtusely rounded at the ends.

Differs from *M. juglandis* (Lib.) in its smaller, definite spots and cylindrical conidia.

ASTRODOCHIUM E. & E., nov. gen.

Sporodochia innate-superficial, formed by the transformation of brown, appressed, branched, radiating fibers. Conidia oblong, continuous, hyaline, borne singly and terminal on simple basidia.

ASTRODOCHIUM COLORADENSE E. & E. On fallen leaves of *Quercus undulata*, Morrison, Colo., December, 1896 (E. Bethel, No. 170).

Epiphyllous, forming round brown spots ½–1 cm. across and having the general aspect of *Asteroma*. The adnate fibers abundantly and sub-oppositely branched towards their extremities are soon transformed into round or elliptical, subdiscoid, light amber-colored sporodochia ¼–½ mm. diam. consisting of closely packed obclavate, 12 x 2½μ, hyaline basidia bearing at their tips the oblong hyaline, 4–6 x 1¼–1½μ, conidia.

Belongs in Fam. *Tuberculariеae, Mucedineae.*

SEPEDONIUM TUBERCULIFERUM E. & E. Parasitic on *Peziza hemispherica* Wigg. and *P. fusicarpa* Ger., Nuttallburg, W. Va., July, 1896; alt. 1800 ft. (L. W. Nuttall, No. 883).

Hyphae effused, forming a thin, white layer on the surface of the hymenium, becoming pulverulent and yellowish at maturity; fertile hyphae with the ultimate divisions di-trichotomously or verticillately branched, the branches lanceolate, 20–30 x 2–2½μ, bearing at their extremities the globose conidia 15–18μ diam., bearing at symmetrical distances on their periphery 8–10 depressed globose, hyaline smooth tubercles 6–7μ diam. and sometimes separable from the central spore.

TORULA ERUMPENS E. & E. On decorticated, weather-beaten wood (poplar)? Morrison, Colo., December, 1896 (E. Bethel, No. 166).

Erumpent in flat, discoid, orbicular or elliptical tufts ½–¾ mm. diam. Conidia cylindrical, 2–5 septate, concatenate, 10–20 x 3½–4μ, dark brown, nearly opaque.

MACROSPORIUM FICI Ell. & Kelsey. On leaves of *Ficus elastica*, Oberlin, Ohio, September, 1896 (Prof. F. D. Kelsey, No. 1076).

Hyphae amphigenous, very dark brown, fasciculate, septate and more or less constricted at the septa, 70–125 x 4–5μ forming olivaceous tufts as large as a small pin's head thickly scattered over the large (1–2 cm.), dirty white spots with a dull purplish-red border. Conidia club-shaped, 3–7 septate, with a more or less complete longitudinal septum, 40–50 x 10–16μ, with a pedicel 20–30μ long.

Quite different from *M. torulosum* Pass. on limbs of *Ficus*.

J. B. ELLIS AND B. M. EVERHART.

Botanical Notelets.—Dr. R. E. Call publishes, in the Journal of the Cincinnati Society of Natural History (March, 1897), an interest-

ing note on the Flora of Mammoth Cave, Kentucky. The species observed are all fungi, as follows, viz.: *Coprinus micaceus, Fomes applanatus, Rhizomorpha molinaris, Microascus longirostris, Zasmidium cellare, Mucor mucedo, Gymnoascus setosus, Sporotrichum flavissimum, Laboulbenia subterranea, Coemansia* sp., *Papulospora* sp., *Bouderia* sp. and *Peziza* sp.

The Annual Report of the State Botanist of the State of New York, for 1894, just issued, is of more than usual interest, since it contains a comprehensive paper on the "Edible and Poisonous Fungi of New York," illustrated by 43 colored plates. Included in the report is a paper by Dr. E. C. Howe on the "New York Species of Carex," in which one hundred and thirty-three species are described at length.

The Report of the Botanical Department of the New Jersey Experiment Station for the year 1896 indicates that Dr. Halsted has been very industrious in his studies of fungicides. The many half-tone reproductions of photographs add much to its value.

Mr. F. L. Stevens has reprinted from the Journal of the Columbus (Ohio) Horticultural Society (Vol. XI, No. 4) a convenient reference index to Dr. Halsted's bulletins and reports on plant diseases. It will be very serviceable to botanists and horticulturists. The same writer published, in the journal cited, an account of the parasitic fungi on Ohio Weeds. Some of these have proved very destructive to their hosts.

Ascherson's "Synopsis des Mitteleuropäischen Flora," of which parts 1 and 2 have been received, promises to be interesting and useful, but its use will be greatly lessened by the failure of the author to properly indicate the authority for each species. The sequence of families in these parts is as follows, viz.: *Hymenophyllaceae, Polypodiaceae, Osmundaceae, Ophioglossaceae, Salviniaceae, Marsiliaceae, Equisetaceae, Lycopodiaceae, Selaginaceae.*

Recent Changes in the Nomenclature of North American Trees.—In looking over the pages of Sudworth's "Nomenclature of the Arborescent Flora of the United States," the writer noted the following changes which are not yet generally found in manuals and lists of species, and which it may be well to reprint here for the benefit of those who do not have access to the most recent literature. It is not thought necessary to repeat the list of hickories (*Hicoria* spp. formerly *Carya* spp.), since the changes in nomenclature which they have undergone are now well-known to every tyro. Nor is it necessary to repeat *Toxylon* (*Maclura*), since it is eighty years since this

name was proposed (1817). In the following list the name accepted by Sudworth appears first, while the name which is still commonly used in the manuals is placed within brackets.

Pinus radiata Don., Monterey Pine (*P. insignis* Dougl.).

Pinus attenuata Lemmon, Knobcone Pine (*P. tuberculata* Gordon).

Pinus virginiana Mill., Scrub Pine (*P. inops* Solander).

Pinus echinata Mill., Shortleaf Pine (*P. mitis* Michx.).

Pinus divaricata (Ait.) Gordon, Jack Pine (*P. banksiana* Lambert).

Picea canadensis (Mill.) B. S. P., White Spruce (*P. alba* Link.).

Pseudotsuga taxifolia (Poir.) Britton, Douglas Spruce (*P. douglasii* Link.).

Sequoia washingtoniana (Winsl.) Sudworth, Bigtree (*S. gigantea* Decaisne).

Chamaecyparis thyoides (L.) B. S. P., White Cedar (*C. sphaeroidea* Spach).

Chamaecyparis nootkatensis (Lamb.) Spach, Yellow Cedar (*C. nutkaensis* Spach).

Chamaecyparis lawsoniana (Murr.) Parl., Port Orford Cedar (*Cupressus lawsoniana* Murr.).

Tumion taxifolium (Arn.) Greene, Florida Torreya (*Torreya taxifolia* Arnott).

Tumion californicum (Torr.) Greene, California Torreya (*Torreya californica* Torr.).

Hicoria laciniosa (Michx. f.) Sargent, Shellbark Hickory (*H. sulcata* (Willd.) Britton.

Salix fluviatilis Nutt., Sandbar Willow (*S. longifolia* Muehl.).

Salix bebbiana Sargent, Bebb Willow (*S. rostrata* Rich.).

Populus deltoides Marsh., Cottonwood (*P. monilifera* Aiton).

Fagus latifolia (Muenchh.) Loudon, Beech (*F. ferruginea* Aiton).

Castanea dentata (Marsh.) Borkh., Chestnut (*C. vesca americana* Michx.).

Quercus minor (Marsh.) Sargent, Post Oak (*Q. obtusiloba* Michx.).

Quercus plantanoides (Lam.) Sudworth, Swamp White Oak (*Q. bicolor* Willd.).

Quercus virginiana Mill., Live Oak (*Q. virens* Aiton).

Quercus velutina Lam., Yellow Oak (*Q. tinctoria* Bartram).

Quercus digitata (Marsh.) Sudworth, Spanish Oak (*Q. falcata* Michx.).

Quercus pumila (Marsh.) Sudworth, Bear Oak (*Q. ilicifolia* Wang.).

Quercus marilandica Muenchh., Black Jack (*Q. nigra* Wang.).

Quercus nigra L., Water Oak (*Q. aquatica* Walter).

Quercus brevifolia (Lam.) Sargent, Blue Jack (*Q. cinerea* Michx.).
Ulmus pubescens Walter, Slippery Elm (*U. fulva* Michx.).
Sassafras sassafras (L.) Karst., Sassafras (*S. officinale* Nees.).
Gymnocladus dioicus (L.) Koch, Kentucky Coffee-tree (*G. canadensis* Lam.).
Cotinus cotinoides (Nutt.) Britton, American Smoke-tree (*Rhus cotinoides* (Nutt.) T. & G.
Rhus hirta (L.) Sudworth, Staghorn Sumach (*R. typhina* L.).
Rhus vernix L., Poison Sumach (*R. venenata* DC.).
Acer saccharum Marsh., Sugar Maple (*A. saccharinum* Wang.).
Acer saccharinum L., Silver Maple (*A. dasycarpum* Ehrhart).
Acer negundo L., Box Elder (*Negundo aceroides* Moench.).
Acer negundo californicum (T. & G.) Sargent, Californian Box Elder (*Negundo californicum* T. & G.).
Nyssa sylvatica Marsh., Black Gum (*N. multiflora* Wang.).
Nyssa ogeche Marsh., Sour Gum (*N. capitata* Walter).
Nyssa aquatica L. Tupelo Gum (*N. uniflora* Wang.).
Mohrodendron carolinum (L.) Britton, Silverbell-tree (*Halesia tetraptera* Ellis).
Mohrodendron dipterum (Ellis) Britton, Snowdrop-tree (*Halesia diptera* Ellis).
Fraxinus nigra Marsh., Black Ash (*F. sambucifolia* Lamarck.).
Fraxinus pennsylvanica Marsh., Red Ash (*F. pubescens* Lamarck.).
Fraxinus lanceolata Borkh., Green Ash (*F. viridis* Michx. f.).
Catalpa catalpa (L.) Karsten, Common Catalpa (*C. bignonioides* Walter).—CHARLES E. BESSEY.

Note on Lysimachia nummularia L.—This plant is found escaped from cultivation near Decatur, Ill. It started from a cemetery, where it is cultivated, and now runs wild over an unused part of the cemetery, and for a distance of half a mile along a little stream running from it. The seeds float down and extend its habitat every year. When it once takes root it drives out all other vegetation except *Nepeta glechoma* and a few tall plants as *Lobelia syphilitica, Impatiens pallida,* etc. It spreads very rapidly, rooting at every node and forming long parallel stems, three to five feet long, making a matted growth. When not in flower it resembles, at a distance, *Nepeta glechoma.* It blooms from June to August. It is often called "wild myrtle."—ALLAN GLEASON, *Secy. Agassiz Asso., Chapter 56.*

Another Popular Botany.—In a pretty little book by Mrs. Dana—"Plants and their Children"—we have an illustration of the

mixture of fact and fancy which the children of the near future are destined to read and pore over in their "Nature Study." The author well says, in her preface: "A child's reading book, it seems to me, should secure for the child three things—practice in the art of reading, amusement and instruction." She has certainly secured the first and second of these objects, and not a little of the third. Had she taken counsel of some good botanist her book might have been more instructive and less misleading. Her description of the bean (on page 81) and her figure 88 are either absolutely incorrect, or, at the least, quite misleading. Similarly misleading is figure 119, the mistletoe (by which the author means the American mistletoe), for it illustrates not the American plant (*Phoradendron*) with which the child is supposed to be familiar, but the Europen (*Viscum*). Figure 136, which is said to show "a seed cut across, and so magnified that you can plainly see its many cells," is a reduced copy of a figure in plate 80 in Grew's Anatomy of Plants, published in 1682! We can not blame old Nehemiah Grew for making such an inaccurate drawing: we may rather give him some praise for doing so well when we consider his tools and environment, but certainly an author must be severely censured who, more than two hundred years later, reproduces it without saying a word as to its incorrectness.

While much of the text is good, some of it is as bad as the cuts we have mentioned. The plant physiology is sometimes ridiculous, often worse. The chapter on "How a Plant's Food is Cooked," is particularly bad. What can we say of a sentence like this: "When the watery broth [in the leaves] is cooked in the sun, the heat of the sun's rays causes the water to pass off through the little leaf-mouths!" Or of this: "There is a tree, called the *Eucalyptus*, whose leaves perspire so freely that it is planted in swampy places in order to drain away the water!"

Mrs. Dana writes so fluently that what she writes is likely to be read with pleasure, and it is her duty to attend much more carefully to her facts. This book must be revised before it can be commended as a reading book for children.—Charles E. Bessey.

VEGETABLE PHYSIOLOGY.

Ecological Plant Geography.[1]—Plant geography can be considered from two standpoints. First, floristic plant geography, which treats of the flora of a region, a list of the species growing within certain geographical limits, the relative proportion of certain species, the relation of an insular flora to that of the mainland, or of a mountain flora to that of the adjacent valleys; that is, facts concerning distribution. Secondly, ecological plant geography, which treats of plant communities as resultants of all the forces working upon them.

The ordinary observer has no difficulty in noting that the plants over one area are different from those over another. He distinguishes the swamp, the meadow, the scrub, the pine-barren, the prairie, and other equally well-marked plant communities. What he notices, however, may not be that certain species of plants grow in one area and certain other species in another, it is rather the general appearance of the area, that is, its *physiognomy*. It is not a difficult matter to determine the species which are associated to form a certain plant community with its corresponding physiognomy. A more difficult question to answer is, however, " Why do these species unite into certain communities, and why have they the physiognomy which they possess?"

It is the task of the author in the 382 pages of the book before us to solve these questions. The author lays down a few general principles, some of which I cannot refrain from giving. " Every species must conform, both in inner and outer structure, to the natural conditions under which it lives, and if, when those change, it cannot adapt itself to them, it will be crowded out by other species, or become entirely eliminated. It is, therefore, one of the first and most important problems of ecological plant geography to understand the *epharmosis* [die Epharmonie, l'epharmonie] of the species, or what can be called its life-form [Lebensform]. This is shown especially in the configuration of the plant and in the duration of the [so-called] organs of assimilation (in the structure of the leaf and of the entire sprout, in the life period of the individual, etc.), and to a less degree in the reproductive organs. This problem leads one far into morphological, anatomical and physiological studies; it is very difficult, but very attractive. It cannot be entirely and satisfactorily solved, but much can be done in the future.

[1] *Lehrbuch der Oekologischen Pflanzengeographie.* Dr. Eugenius Warming. Translated from the Danish by Dr. Emil Knoblauch, 1896, Berlin, Gebrüder. Borntræger.

"What increases the difficulty of the problem is, for example, the fact that besides the conforming power of many external factors, and besides the adaption of species to these factors, there are innate, hereditary dispositions, that from inner unknown causes produce structures which we cannot bring into any relation to the surrounding natural conditions, at all events not to those present, and which we cannot therefore understand. These inner dispositions, different according to the natural relationship, bring along with them this, that the development of the species under the influence of the same factors can lead to the same result in entirely different ways. While, for example, one species adapts itself to a dry habitat by means of a thick coating of hair, another species under the same conditions cannot bring forth a single hair, but choses, for example, to cover itself with a layer of wax, or to reduce its foliage and become a stem-succulent, or becomes ephemeral in its development." This paragraph explains fairly well the scope of the problem which the author endeavors to solve.

The term "Lebensform" is further explained. The cactuses, fleshy euphorbias and the succulent stapelias, though belonging to widely different families all possess the same life-form.

In a certain area or habitat, certain species have adapted themselves to the conditions there present, and so form a plant community (Pflanzenverein). Of course these plant communities cannot always be sharply divided, and the same species may occur in more than one community. But, nevertheless, each community possesses its peculiar physiognomy.

"Ecological plant geography must deal with the following:

"1. The factors of the outside world that play a rôle in the economy of plants, and the action of these factors upon the external and internal structure of plants, upon the life-period and other ecological relations, as well as upon the topographical limits of the species.

"2. Grouping and characterizing of the classes of communities (Vereinklassen) present upon the surface of the earth.

"3. The conflict between the communities."

The first section of the work deals with the ecological factors. The atmospheric factors are light, heat, moisture and air currents. The terrestrial factors are composition and physical condition of the soil, air and water in the soil, and other physical characters; the effect of dead or living mantle (snow or fallen leaves) upon the surface, of animals (earth-worms, moles, etc.), or plants (fungi, bacteria) beneath the surface of the soil, and finally, the effect of the direction and height of mountain chains, angle and direction of slope, and similar considerations.

But plants must adapt themselves not only to the physical conditions mentioned, but also to animals and to other plants. Man is far from an insignificant factor. The interdependence of plants and animals, such as flowers and pollinating insects, plants and ants, etc., though not discussed at length, plays a more or less important part in the battle.

The greatest struggle, however, is that which takes place between the plants themselves. A more or less stable equilibrium has been established in several ways. Parasitism, helotism (applied by the author to the relation of organisms in the lichen thallus), mutualism (root tubercles, etc.), epiphytes, with all their curious adaptations, saprophytes, lianas, are carefully considered. Over a given area where the various factors are comparatively constant, certain species are found which have adapted themselves to these conditions and to each other. These together make the plant community and present to the eye a certain physiognomy. Two plant communities living under similar conditions may present similar physiognomies, but may consist of widely different series of species. With the exception of subglacial and desert regions there is a conflict among individuals, those inherently less hardy and those accidentally unfavorably placed being first to succumb.

Hence, we have a kind of association known as commensalism. This term is sometimes used in the sense of mutualism (symbiosis); but, as used by the author, it means rather an established equilibrium between individuals struggling for the same food. It is to be noted that the strife between individuals of the same species is much greater than that between individuals of different species, since, for example, they may use different materials in the soil.

The first 120 pages of the work is taken up with preliminary discussions, as briefly outlined. The author gives a classification of the various plant communities. They are grouped in four classes, depending upon the relations of these to water. "The regulation of transpiration of plants appears to be the factor which influences most profoundly the forms of plants, and which imprints upon them most markedly their external characters. If the evaporation is greater than the water supply, the plant wilts, and this influences the most important life processes, even if it does not go so far that death results."

The classes are as follows:

"I. Hydrophyte-vegetation.—This is an extreme vegetation whose plants are either wholly, or, for the most part, surrounded by water, or grow in soil well filled with water (the per cent. of water amounts to probably more than 80).

"II. The XEROPHYTE-VEGETATION is the opposite extreme, whose plants grow upon stony soil, or, at least, during a greater portion of the year, in soil scarcely supplied with water, and in dry air. The water content can, indeed, if it is at a minimum amount, be less than 10 per cent.

"III. The HALOPHYTE-VEGETATION is closely related morphologically to the foregoing, but merits a separate consideration, an opinion that is confirmed, among others, by the investigations of Stahl. It is a very extreme vegetation, that is limited to salty soil and whose morphological peculiarities appear likewise to be caused by the regulation of evaporation.

"IV. The MESOPHYTE-VEGETATION includes the communities that are adopted to a soil and air of medium moisture, and to a soil also which is not particularly salty. The plants form a morphological and anatomical standpoint, are not especially extreme in their characters."

Space will not allow even an outline of the interesting chapters following, but for illustration we will glance at the xerophytes.

In the xerophytes adaptation has taken place along two lines, reduction of the transpiration during the critical period, and a development of especial means for gathering or storing water. Regulation of transpiration may be accomplished by reducing the evaporation in the following ways: 1. Periodical reduction of evaporating surface; deciduous trees dispense with their leaves in winter, bulbous plants relinquish the exposed parts in the dry season, annual plants pass this season in the seed stage; the leaves, especially of grasses or the thallus, may roll up in various ways. 2. The leaves change their position so as to regulate the amount of light, and consequently the amount of heat which they receive from the sun; many *Leguminosæ* place their leaflets in a vertical position during the heat of the day (para-heliotropism). Even our much-despised purslane shows this on a hot day; the common impression being that it is wilting—it knows better than that. 3. A permanent vertical position of the foliage organs. If the leaves are upright they tend to throw their surface into a meridional plane (compass plants). The leaves may be directed outwardly and twisted on their petioles (*Eucalyptus*), or hang on slender petioles (cotton-wood). The petioles may be laterally flattened and take the function of foliage (many *Acaciæ*). 4. The surface may be reduced in proportion to the volume, such as the needle-like leaves of the pine, the succulent leaves of the sedums, or where the stem acts as foliage and the leaves are reduced to scales, as in the cactus or asparagus. 5. The evaporation may be hindered by a coating of hairs, a common contrivance in dry regions,

giving usually a gray color to the physiognomy. The hairs must be dead and filled with air. 6. Anatomical structure. The epidermis may be cutinized, or encrusted with various substances; the stomata may be sunken or otherwise protected. The contrivances for this purpose are legion. 7. The author calls attention to the frequent presence of etherial oils in xerophytes, and, though the use is not clear, suggests that the leaf becomes coated with a layer of the vapor of this volatile oil; and, since this layer is much less diathermous than air, the evaporation is lessened.

Under adaptations for absorbing water may be mentioned certain glandular hairs of desert plants and air-roots of epiphytic orchids. Some kinds of glandular hairs secrete hygroscopic salts, such as calcium chloride, which readily absorb water. "Volkens thinks that the plants take up water in this way. Marloth, however, regards this salt coat only as a covering to hinder transpiration, and even thinks that the plants thus free themselves from a part of the salts taken up."

Under storage of water we have various kinds of water tissue, succulent plants with sap which does not readily part with its water, and fleshy underground parts.

An outline of the xerophite classes may be of interest.

"A. Rock vegetation, that of the subglacial and temperate regions: that of dry tropics.

"B. Subglacial vegetation upon loose earth. Stony plains sparsely beset with plants, due often to lack of warmth rather than lack of moisture; moss heaths; lichen heaths.

"C. Dwarf-shrub heaths (mostly *Ericaceæ*).

"D. Sand vegetation, Strand flora, discussed more at length under Halophytes; vegetation of shifting dunes; vegetation of permanent dunes; sandy scrubs and timbered barrens.

"E. Tropical deserts.

"F. Xerophilous, herbaceous vegetation. Steppes and prairies; savannahs.

"G. Stony heaths (Felsenheiden) such as the Asiatic steppes covered with thorny shrubs.

"H. Xerophilous scrubs (Gebüsche). In arctic and temperate regions; in Alpine regions; tropical thorn-, palm-, fern-, bamboo-scrubs, etc.

"I. Xerophilous forests. Evergreen conifers; deciduous conifers; xerophilous, deciduous forests; leafless forests (*Casuarina*)."

The other three primary divisions are discussed in a similarly thorough manner. Swamp plants frequently possess xerophilous char-

acters. Many suggestions are made to explain this, such as: in regions of high latitude or altitude, xerophilous characters lessen evaporation early in the season, when the roots are inactive, due to cold soil; or the activity of the roots is hindered by the difficulty of aeration, hence the need of lessened evaporation; or, again, since the stomata remaining open, cannot regulate evaporation, xerophilous characters are necessary.

The most probable explanation of the presence of xerophilous characters in halophytes is that the roots have difficulty in obtaining water from the strong solution of salts in which they are placed, hence the necessity of lessened evaporation.

The closing section treats of the struggle between the various plant communities.

The book should be read by every student of ecology; but more, the general reader would be amply repaid by its perusal. It is to be hoped that the book may be translated into English.*—A. S. Hitchcock.

ZOOLOGY.

The Gas of the Natatory Vessels of Physalia and of Fishes.[1]—As a result of a search[2] for argon in the natatory vessels of *Physalia* and of fishes there were found in the vessel of the former (*Physalia pelagica* Lk) from 85–91 per cent. of nitrogen, and from 9–15 per cent. of oxygen, but no other gas. In the swimming bladder of surface fish (*Polyprion cernium* Val.) there was found about 80 per cent. of nitrogen, 18 per cent. of oxygen, and 2 per cent. of carbonic acid gas, while in deep sea forms, such as *Murœna helena*, taken from a depth of 88 meters, and *Synaphobranchus pinnatus* Gr., taken from a depth of 1385 meters, 3–6 per cent. of carbonic acid gas and oxygen in the large amount of 73–85 per cent. were found.

The Genus Ascaris.—In his monographic work[3] devoted to this genus of worms, Stossich considers 218 species. Of this number 35

*An English translation of this book is now in preparation and will be published by Macmillan.—Ed.

[1] Richard A. (96). Sur les gas de la vessie natatoire des poissons et des physalies. Bull. Mus. Hist. Nat., Paris, 41-3.

[2] Schloesing, Th., and Richard J. (96). Recherche de l'organ dans les gas de la vessie natatoire des poissons et des physalies. Compt. Rend. Ae. P., CXXII, 615-7.

Zool. Centralbl., IV, 19.

[3] Bull. Soc. Adriat. Sc. Nat., Trieste, XVII (1896), pp. 7-120. Zool. Centralbl., IV (1897), p. 20.

occur in mammals, 47 in birds, 29 in reptiles, 5 in amphibians, 98 in fishes, 1 in an insect, and 1 in an unknown host. 117 of the lot, are doubtful forms. The remaining 101 Stossich divides into groups: (1) those with a dentated fold and no median lip; (2) those with both dentated fold and a median lip; (3) those with the median lip but not the dentated fold; and (4) those with three simple lips. 32 of the lot are larval forms mostly from fishes.

The Excretory Organs and the Blood-Vascular System of Tetrastema græcense Böhmig.[4]—The small fresh-water nemertine that was first discovered by Böhmig in 1892 has since then been found in sufficient numbers to enable its discoverer to give a brief description of the excreto-genital and the vascular systems. The former is easily recognized in compressed animals, and appears as a system of coiled and anastomosing tubes along each side for the whole length of the animal. The tubes of opposite sides do not unite, although their very close contact sometimes causes them to seem to do so. At the anterior end of the animal near the brain there is only one canal, which is large, coiled, and looped, and ends finally in a meshwork-like system of smaller canals. Nothing like it appears at the opposite end of the animal. Into the larger, as well as into the smaller canals, empty numerous fine canals, which arise from the end-organs.

In the organs, he distinguishes three portions: (1) the terminal canals, (2) the connecting canals, and (3) the end-organs. The first lie mostly between the external muscle layer and the intestine, and are formed by cells unprovided with cilia. They connect with the excretory pores, of which there may or may not be an equal number on each side of the animal. In one case there were 5 pores to a side; in another, 6 on one, and 3 on the other side.

The connecting canals are distinguishable from the others by their greater thickness and the nature of their bordening cells, which bear cilia. The rounded, superficially smooth end-organs are provided at their free ends with two (seldom only one) flame cells, and seem to be formed by 3–5 cells resembling those of the terminal canals in appearance. In general it may be said that they communicate with the terminal canals only through the mediumship of the connecting canals. Yet, a direct connection between the two has been seen.

The vascular system consists of 3 branches, 2 lateral vessels, and a dorsal vessel. Near the brain the last communicates with the right

[4] Böhmig (97). Vorläufige Mittheilung über die Excretionsorgane und das Blutgefässystem von *Tetrastema græcense* Böhmig. Zool. Anz., XX, 33–6.

lateral vessel, and posteriorly with both the right and left vessels through an anal commissure. The walls of the vessels are formed of (1) an inner endothelial, (2) a circular muscular layer, and (3) an outer layer of mesenchymal cells arranged like an epithelium. Between the endothelial and the muscular layers are large cells of a hemispherical form and peculiar structure, which, at the moment of diastole, stand out from the wall of the vessel, and at the time of systole plunge into it. They appear to guide the flow of the blood.

A connection between the nephridia and the vascular system, such as Berger has described for marine nemertines, especiallly for *Drepanophorus*, does not occur.

The Existence of Epitokic Forms in the Annelid Family Cirratulidæ.[5]—Two members of this family, namely, *Dodecacerca concharum* Örst. (=*Heterocirrus ater* Qfg.) and *Heterocirrus flavoviridis* St. Jas. have been found in an epitokic stage, which differs from that of certain of the Licoridæ and Syllidæ: (1) in the possession of very long swimming processes in the dorsal branch of the parapodia, (2) in having two highly developed eyes on the cephalic lobe, (3) in the shortness of the feeler of the first segment, (4) in the slightly spatula-form of the end of the body, (5) in the irregular coloring, (6) in a different musculature, and (7) in the possession of mature sexual products. The individuals are of different sexes. In August atokic and epitokic forms as well as connecting forms are found side by side.

A Study of the Form of the Crop of the Libellulidæ and their Larvæ.[6]—Recently a number of anatomical observations made by the author cited, on the form of the crop, the distribution of the "teeth," etc., in the same, have been made use of for systematic and phylogenetic purposes. A series of the larvæ and imagines of the genera, *Calopteryx, Agrion, Pyrrhosoma, Erythromma, Enallagma, Ishnura, Platycnemis, Lestes, Gomphus, Æschna, Anax, Corduligaster, Diplax, Libellula, Epophthalmia, Cordulia,* and *Orthetrum*, were studied, and as a result the conclusion arrived at that the crop of Colopteryginæ represents the primitive form. This shows sixteen areas irregularly covered with teeth. A perfection of this form appears in the Agrioninæ, in which there is a greater supply and a more regular arrangement of the teeth. In the case of the genus *Lestes* there are but eight longitudinal folds, a number that in the gomphininæ and æschninæ

[5] Mesnil, F., and Caulbry, M. Compt. Rend. Ac. Sc. Paris, 1896.

[6] F. Ris. Untersuchung über die Gestalt des Kaumagens bei den Libellen und ihren Larven. Zool. Jahrb. Abth. Syst., IX (1896), 596–624.

is reduced to four. While the *Condulegaster* show a striking concentration of the armature, which is limited to two pairs of teeth. In fact, the original radially symmetrical arrangement is seen to have been transformed to a bilateral one. The structures are best studied in the larvæ, for they become considerably reduced and obscured in the imago. Summarizing his results in the form of a phylogenetic tree the author considers the agrioninæ and the petalurinæ to have arisen from the primitive form, calopteryginæ. Then from the petalurinæ there arose three branches, two of them terminated by the æschninæ and the gomphinæ respectively; the third passed off to one side as a low branch that formed the cordulegastrinæ. From this form there arose one branch that soon divided and finally gave rise to the corduliinæ and the Libellulinæ, the highest of the dragon-flies. The author's conclusions differ from those of Calvert in that the cordulegastrinæ form a link between the two forms represented by the subfamilies corduliinæ and Libellulinæ, and that represented by the petularinæ, instead of an independent branch.

The Regeneration of an Antenna-like Structure Instead of an Eye.—The regeneration of a structure very much resembling that animals antennula on the stump of an eye stalk of *Sicyonia sculpta* is well worth recording along with the regeneration of a well-formed lens from the iris in *Triton*, as described by Wolff and also by Müller whose paper was noted in the NATURALIST some time ago (p. 72).

The regeneration of such a structure is described by C. Herbst[7] in several out of eighty-five specimens from which he cut the eye. Only six of the eighty-five remained alive at the end of five months after the operation, but all but one of these showed evidence of a regenerated structure. Some seven other cases were secured during the five months by fixing the animals recently dead, or about to die, so that he had twelve good cases showing a regenerated structure. Similar experiments had previously been performed upon the eye stalk of *Palæmon*, with like results.

The accompanying figures represent the three groups into which Herbst divides the regenerated structures according to their degree of perfection. In the first (fig. 1) there is shown only a small protuberance (n) having little evidence of segmentation. In the second group (fig. 2) there is developed a large process provided with two hairy areas and a secondary two-jointed lobe that Herbst likens to a crustacean flagellum (*fr*). In the third group (fig. 3) a large antenna-like struc-

[7] C. Herbst. Festschrift der Naturf. Gesel. Zurich, 1896, pp. 435–54.

ture is developed, having, like the last structure, two hairy areas (which do not normally occur on the eye stalk), and, in addition, two

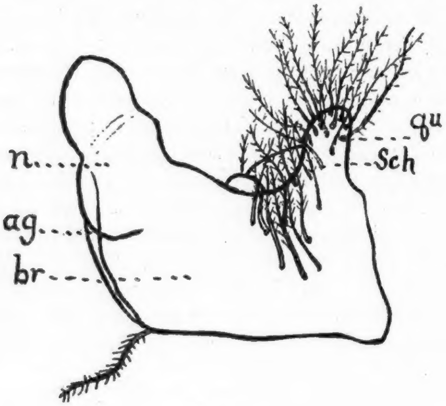

Fig. 1.

several jointed processes. This last figure scarcely needs the detailed argument that Herbst devotes to it to prove that it is antenna-like, and

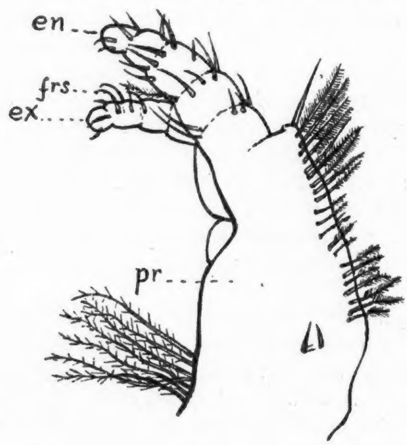

Fig. 2.

to show that the endopodite (*en*), exopodite (*ex*) and protopodite (*pr*) are represented.

The occurrence in crustacea of an antenna-like organ in the place of an eye was noted as early as 1864 by Milne-Edwards[8] in the lobster, *Palinurus penicillatus,* and later (1894) by Hofer[9] in *Astacus.* To ask what bearing these cases and the results of Herbst's experiments have upon the general question of arthopod segmentation is but to repeat the query made by Milne-Edwards. He thought that he had found new

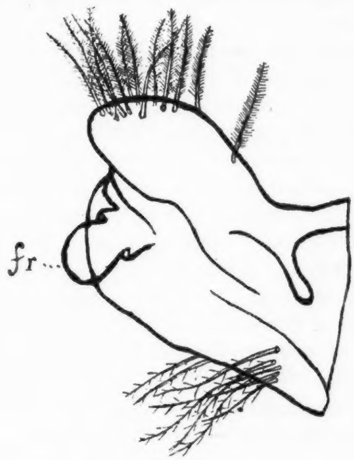

Fig. 3.

evidence of the truth of Savigny's law. Later, writers have not generally considered the eye or optic stalk as the homalogue of a segmental appendage, nor have they considered the protecerebral lobe, from which the eye is innervated, as evidence of a segment. It may be a hasty conclusion, but the cases of an antenna-like structure certainly seem to indicate that Milne-Edwards was right, and that one may in the future be obliged to consider the arthopod head as having one more segment in it than we have till now supposed it to have. Further experimentation is necessary to show what internal structures are regenerated, for Herbst seems to have made no sections whatever of the structures that he describes. One would like to know to just what extent the muscles are developed, and what happens to the stump of the optic nerve. Experiments should also be made to determine what, if

[8] Hofer. Ein Krebs mit einer Extremität statt eines Stielauges. Verh. d. Deutsch. Zool. Gesel., 1894.

[9] A. Milne-Edwards. Comp. Rend. Acad. Sci. Paris (1864) LIX, pp. 710–12.

any, differences are to be noted when the stalk is cut through at different distances from the eye so as to leave intact different portions of the optic ganglia.—F. C. KENYON.

Variability of External Sutures in the Skull of Chelone mydas L.—In a paper entitled Bemerkungen über die Systematische Stellung von Dermochelys Blainb.,[10] Baur quotes from Boulanger, as follows:

"The lower border of the post-frontal joins the jugal and the squamosal, and cantrary to what exists in the Cheloniidæ is separated from the quadrato-jugal by the two latter bones." Baur then adds that he finds the same relation in two specimens of *Chelone mydas* L.

I have before me three skulls of *Chelone mydas* L. from the Atlantic coast, one from an animal weighing about thirty pounds, and two of quite precisely the same size from specimens which weighed from sixty to seventy pounds. In the first, or small skull, I find the squamoso-jugal separation, as well as in one of the larger skulls. In the third there is a distinct squamoso-jugal union. Internally the skulls all agree. Further differences in these skulls are slight. There is apparently no order for the junction right and left of parietals and frontals, and frontals and parietals. These, with the squamoso-jugal union or non-union should be recognized as altogether variant characters in the osteology of *Chelone mydas* L.—GEO. R. WIELAND.

Lists of Mammals of Raleigh, N. C.—The following list of the mammals found near Raleigh, N. C., is based on twelve years of mammal collecting in this vicinity, and observations made since 1880 on the mammals of this locality by my brother and myself. We have preserved some 1,500 or 2,000 specimens as skins, or alcoholics, besides catching in our trapping a number of others which were not preserved. A number of specimens have been bought from the farm hands employed in ploughing, or cutting hay, thus adding considerably to our knowledge of several species, notably *Zapus hudsonius*. The country lying immediately southeast of Raleigh, where most of the collecting was done, is mostly rolling country, except along Walnut Creek, where there are considerable tracts of wet meadow and some good sized cat-tail swamps. The drier portion of the country collected over is about one-half cultivated, and the other half woodland.

The commoner mammals are distributed as follows: *Sciurus carolinensis* and *Sciuropterus volans* in woods, the third arboreal species, *Pero-*

[10] Biologische Centralblatt, Dec., 1889, Erlangen.

myscus aureolus, being an inhabitant of damp thickets. *Lepus sylvaticus*, *Peromyscus leucopus*, *Blarina carolinensis* and *Scalops aquaticus* are found nearly everywhere in woods and fields both, except in the more watery situations, where only aquatic species occur; *Microtus pinetorum* is found in the drier woods and fields; *Sigmodon hispidus* in the drier fields, but not in woods. *Mus musculus*, *Reithrodontomys lecontei*, *Blarina parva* and *Microtus pennsylvanicus* occur in open fields and the edges of the marshes, the last species penetrating the marshes much farther than the others. *Oryzomys palustris*, *Fiber zibethicus*, *Lutreola lutreocephalus* and *Lutra hudsonica* are all more or less aquatic, being found mainly or entirely along streams, or in the wet marshes. Of the bats, *Vesperugo carolinensis* is the common bat of the low grounds, and *Atalapha borealis* of the uplands.

The species observed here, are as follows:

1. *Didelphis virginianus.* Opossum. Tolerably common. I once took a litter of fourteen young ones, August 4, 1891.

2. *Lepus sylvaticus.* Cotton-tail Rabbit. Common. The young of this species are blind at birth.

3. *Mus alexandrinus.* Roof Rat. The long-tailed, white-bellied Roof Rat is common here, around houses and farm buildings, but is not found away from such places (*Mus decumanus* and *Mus rattus* I have never observed at Raleigh).

4. *Mus musculus.* House Mouse. Common in houses, and irregularly distributed throughout all open fields.

5. *Sigmodon hispidus.* Cotton Rat. Abundant in the upland fields, particularly in gardens and in grain and clover fields. By far the most diurnal in its habits of any of our mice.

6. *Peromyscus aureolus.* Golden Mouse. Common in damp thickets. Nests in reeds, bushes or vines. Our only arboreal mouse.

7. *Peromyscus leucopus.* White-footed Mouse. Abundant everywhere, except in the wet marshes. Nests in the rotten roots of old stumps below ground, or in hollows of dead stumps above ground.

8. *Oryzomys palustris.* Tolerably common in the wet marshes and cat-tail swamps. The nest is built in a bush or bulrush tussock often fifty yards from land.

9. *Reithrodontomys lecontei.* Harvest Mouse. Abundant in the open fields and on the edges of marshes, but is not found in woodlands. The few nests I have found have been in bulrush tussocks in rather damp situations.

10. *Microtus pinetorum.* Pine Mouse. Fairly common, found in the drier parts of woods and fields, and is more subterranean in its habits

than any other of our mice, and also, I think, more so than any of our Shrews.

11. *Microtus pennsylvanicus.* Meadow Mouse. Found to a greater or less extent in all open fields, but reaches its greatest abundance in the wet meadows, where its habitat overlaps that of *Oryzomys.* It is not found in the woodlands.

12. *Fiber zibethicus.* Musk Rat. Common in marshes and along the larger streams. A black color phase or variety occurs which is black above with lighter under-parts and cheeks than the common form. The black form is one-fourth or one-third as common as the ordinary brown phase.

13. *Scurius carolinensis.* Southern Gray Squirrel. Tolerably common in all woodlands (Although I have made very careful inquiries I have been unable to find any evidence that the Fox Squirrel ever occurred here).

14. *Sciuropterus volans.* Flying Squirrel. Common. Strictly nocturnal.

15. *Tamias striatus.* Chipmunk. They are fairly common about six miles west of Raleigh, but are totally absent from my immediate neighborhood.

16. *Zapus hudsonius.* Jumping Mouse. Rare. The one or two dozen specimens we have secured here come from upland, lowland, woods and open fields. An adult female and eight young were caught in a nest by some field hands, and brought to me, June 13, 1895.

17. *Sorex longirostris.* Rare. Only seven specimens obtained so far. This species is found on comparatively high ground, not in swamps nor on the edges of them ; it has not so far been taken in woods, though one specimen was caught just on the edge of some woods. This is the smallest of our mammalia.

18. *Blarina parva.* Little Blarina. Tolerably common. Is either only abundant in particular situations, or else it has become much scarcer in the last few years. Is found in open fields (and the edges of the more upland marshes to some extent).

19. *Blarina carolinensis.* Carolina Blarina. Abundant. This species I believe to have become more abundant of late years ; its distribution here is the same as that of *Peromyscus leucopus*, namely, everywhere, except in the wetter marshes, where *Oryzomys palustris* and *Microtus pennsylvanicus* are the only small mammals.

20. *Scalops aquaticus.* Common Mole. Abundant everywhere.

21. *Vespertilio lucifugus.* Little Brown Bat. Rare. Only two specimens so far.

22. *Lasionycteris noctivagans.* The Silver Black Bat is rather rare here. I have several times had specimens brought to me in winter that were captured in hollow trees.

23. *Vesperugo carolinensis.* This and the Red Bat are our two most abundant bats. Very common.

24. *Adelonycteris fusca.* Large Brown Bat. Rare. Only about a dozen specimens taken.

25. *Nycticejus humeralis.* The Twilight Bat is fairly common here, but never occurs in half the numbers of the Red Bat, or *Vesperugo carolinensis.*

26. *Atalapha borealis.* Red Bat. Abundant. This bat flies later in the autumn and earlier in the spring than any other of our bats. The number of young at birth is usually three, while in *Vesperugo carolinensis* and *Nycticejus crepuscularis* two is the normal number.

27. *Lutra hudsonica.* Otter. Occurs on all the larger streams. My brother, H. H. Brimley, has caught eight specimens at various times.

28. *Mephitis* (*sp*). A Skunk was killed near Raleigh a few years ago, the only one we ever heard of.

29. *Lutreola vison lutreocephalus.* Southern Mink. Common along water-courses. The females (and sometimes the males) are not infrequently brought to me as "Weasels."

30. *Putorius noveboracensis.* Weasel. One male caught by my brother, when trapping, January 13, 1888. I have heard of others, but have never been successful in getting them.

31. *Procyon lotor.* Raccoon. Quite rare in the immediate vicinity of Raleigh.

32. *Urocyon cinereo-argentatus.* Grey Fox. Not infrequently caught by fox-hunters in this vicinity. The Red Fox is said to occur in adjoining counties.—C. S. BRIMLEY.

ENTOMOLOGY.[1]

Insects Affecting Domestic Animals.—In the last issue of the new series of Bulletins of the U. S. Division of Entomology (No. 5), Prof. Herbert Osborn devotes nearly 300 pages to a treatment of this subject. The bulletin is an important and extremely useful one, with 170 illustrations. In the introduction there is a general discussion of parasitism from which we extract the following regarding the origin

[1] Edited by Clarence M. Weed, New Hampshire College, Durham, N. H.

and results of parasitism. The problems of the origin of parasites, or the adaptation of certain forms to a parasitic life, are among the most interesting met with in biological investigation, but we can suggest merely some of them here.

It may be said from the biological standpoint that all parasites have been derived primarily from non-parasitic forms—a proposition which is supported by innumerable facts in their morphology and embryology, and which may also be argued deductively. Since many species are confined absolutely to certain animals as hosts, it is evident that they could not have existed as parasites upon such species at least before the occurrence of the host. Unless, therefore, we claim an independent origin for them subsequent to the origin of the host we must allow an adaptation from some free-living species or from a parasitic species on some other host, and following this back for its origin, we must ultimately arrive at a free form as the source.

In many cases the line of evolution is very apparent, as, for instance, the gradation between comparatively free and fixed Mallophaga, Acaridæ, Pulicidæ, etc.

RESULTS OF PARASITISM.

It is also interesting to inquire as to the effect of the parasitic life upon the parasite itself.

The natural tendency of an animal once started in the direction of parasitism will be to become more and more parasitic in habit, and with this habit a greater and greater specialization of parts with reference to this habit will be observed. The disuse of certain organs, as wings for flight and feet for ordinary locomotion, results in reduction or modification of these organs, and hence we find almost invariably that parasitic species are wingless, and that they have the feet adapted specially for locomotion among the hairs or feathers of the hosts. This adaptation is often looked upon as degradation; but it seems to me preferable to consider it as a limitation in certain directions with specialization of certain organs. We consider the foot of the horse highly specialized, and we must admit that the animal is limited in its use, as it cannot climb trees, but we do not call the horse degraded.

It is true that the limitations for many parasites are so great that they are absolutely dependent upon certain hosts, and the presence of certain conditions for their existence—there is reduction or degradation of certain organs, but progressive specialization of those organs which remain functional. Often such specialization assumes a parallel character in widely divergent groups, as the clasping organs developed in

pediculids, mallophagids, hippoboscids, and sarcoptids. In other cases the same effect is attained by a different process, as the flattening of the body vertically in fleas and horizontally in most other permanent parasites. Modifications of the mouth-parts, eyes, and antennæ are very great, and furnish most striking examples of the modification of structures for the adaptation to special conditions.

Life-History of Coleophora malivorella.—In an admirable Bulletin (124 of Cornell Experiment Station), Mr. M. V. Slingerland discusses the Pistol Case-bearer, summarizing its life-history thus: The insect spends about seven months (from September 1st to April 1st) of its life in hibernation as a minute, half-grown caterpillar in a small pistol-shaped case attached to a twig. In the spring the caterpillars attack the swelling buds, the expanding leaves, and especially the flowers. About May 1st the cases are fastened to the twigs, where they remain for four days, during which time the caterpillars shed their skin or moult. They do not make any complete new suit as they grow, but are content with making additions to the ends and side of the old suit. They are not miners, but feed openly, eating irregular holes in the leaves, often skeletonizing them. They are most destructive on the flowers, where they eat the petals and stems. In the latter part of May they cease feeding, securely fasten the cases to the branches, and in about two weeks change to pupæ within. The moth emerges in two or three weeks, and soon glues its minute, pretty, cinnamon-colored, inverted cup-like eggs to the surfaces of the leaves. The egg-stage lasts about a week, the little caterpillar emerging about July 22d. They begin eating little holes in the leaves, and during their first meal construct of silk and excrement a small case or suit for themselves. They continue feeding on the leaves, adding to their suits from time to time, until about September 1st, when they begin to migrate to the twigs, and there fasten their little pistol-shaped cases to the bark. The winter is passed in these snug, warm, secure quarters.

Studies of Mimicry.—Col. C. Swinhoe, after studying and thinking over the general theory of protective mimicry, conceived that the subject should be advanced by the study of a small group of widespread mimetic species throughout the different countries included in its range. While the Bolina group of Hypolimnas contains according to systematists a number of species, they can all be merged into two, and it was these that he selected for his purpose. He describes in detail the appearances of these widely spread forms, and comes to the conclusion that the facts afford the strongest support to the theory of mimicry as

originally suggested by H. W. Bates; a variety of changes which occur are explained by this theory and by no other yet propounded. Local changes may be explained in many ways; but that they should invariably be in the direction of a superficial resemblance to one butterfly, and that one a specially defined species, is only to be explained by the theory of mimicry. Although much support has been afforded to this theory since Bates propounded it in 1862, Col. Swinhoe states that no evidence is so complete and convincing as that supplied by the genus Hypolimnas. If we are right in believing that the results are determined by the range and abundance of mimetic forms, it is clear that selection, rather than unguided variation, is the essential cause of the phenomena.—*Journ. Royal Microscop. Society.*

Remarkable Vitality.—Early in September, 1896 I collected two forms of life from Great Salt Lake, one was the brine shrimp *Artemia fertilis*, the other the larva of a fly, the *Ephydra gracilis.*

After keeping these in salt water for ten days I washed them in fresh water, and then placed them in a small vial *filled* with a 3 per cent. solution of formaline.

After they had been in this solution for ten days I had occasion to examine them, and on taking them from the vial I found that thiee of the Ephydras were still living and active. The vitality of the Ephydra seems to be fully equaled by the vitality of the *Stenophelmatus fasciatus* order Orthoptera. Some fragments of this insect were sent to the University of Utah for identification. Among the fragments was the prothorax bearing the head. This piece lived for nine days, and during that time when ever it was irritated would attempt to bite with its powerful jaws. It would also turn over into its natural position when placed on its back.—C. A. Whiting.

EMBRYOLOGY.[1]

Two animals from one egg.—To the many known cases in which two animals may be obtained from one egg by experimental interference, may now be added the amphibian *Triton cristatus.* By the aid of a simple piece of apparatus Amedeo Herlitzka[2] succeeded in

[1] Edited by E. A. Andrews, Baltimore, Md., to whom abstracts, reviews and preliminary notes may be sent.

[2] Archiv f. Entwicklungsmechanik. IV, März 2, 1897, pps. 624–654, pl. 27.

isolating the first two cells of the egg and ultimately obtained from each cell a perfect, symmetrical, free swimming larva.

Contrary to what has often been stated for the result of similar experiments upon other animals these larvæ are not half the normal size, though each arises from half an egg.

Each larva is larger than half a normal larva. There are also certain remarkable facts concerning the size of the organs and the number of cells in these half-egg larvæ. Thus while the intestine and the muscle segments appear on transverse section much smaller than in the normal larva, the medulla and the notochord are *equal* in transverse section to the normal. In the medulla and in the muscle segments the nuclei have the same size in the half-egg larvæ as in the whole egg larvæ.

The number of cells seen in cross section is half as great in the muscle segments of the half-egg larva while the number of cells in the medulla is the *same* in the half-egg larva as in the whole-egg larva!

It seems that certain structures may be formed with less than the normal number of cells while others have the normal number.

Do the Astral Rays pull or push?—Ludwig Rhumbler[3] concludes that the radiations often seen as star-like figures during cell division are probably lines of pulling or drawing and not lines of extension or pushing. He thinks the only adequate explanation of cell division is one based upon Bütschlis' theory of the foam-like structure of protoplasm and in deciding in favor of a contractile rather than an expansive action along the astral rays he thinks he brings support to the foam theory of protoplasm.

In a previous paper[4] he began the first of a series of attempts to explain cell division upon a physical basis; he assumed a vesicular or foam-like structure for protoplasm and also certain chemical changes in the centrosomes leading to periods of great absorbtion of liquid. The withdrawal of liquid from the vesicles round about leads to tensions and, if rapid enough, to the appearance of radiating lines of vesicles. Based then chiefly upon phenomena of surface tension in the constitutent vesicles of protoplasm, each a viscid bag with more liquid contents, this hypothesis seeks to reduce all the complexities of cell division to a very few physical laws.

The present paper gives a few noteworthy figures of sections of snail's eggs showing a marked vacuolated or vesicular appearance in the pro-

[3] Archiv f. Entwicklungsmechanik. IV, März 2, 1897, pps. 659–725. Pl. 28.
[4] See American Naturalist for January, 1897, p. 84–6.

toplasm around the centrosome and also representing the astral radiations not as mere lines but as flat ribbons or plates. In the author's mind this means that the rays are not muscle-like fibrils, but the fused walls of alveoli or vesicles—hence their flat appearance.

The main part of the paper is taken up with the consideration of certain interesting experiments devised to illustrate the action of a set of contractile elements. Modifying the model of Heidenhain the author constructed a schema to illustrate cell division as follows: a circle of rubber tubing is made more or less rigid by steel rods inserted inside it or by means of a spiral spring—this represents the periphery of a cell; from the periphery to the center are stretched elastic bands of rubber which represent the astral rays; these are attached to two masses (forming the hub in this wheel) which may be at the centre or separated like the foci of an ellipse, when they represents the two centrosomes. According as the rim of the wheel is stiff or limp and the halves of the hub united or apart and according to the strength of the radiating bands various forms will be assumed by the system when at rest. By this scheme the author makes clear that a system of radiating contractile elements in conjunction with a somewhat resistant periphery can make various diagrams that show resemblances to phases of cell division in the behavior of the cell periphery, the length of the astral rays and the movements and positions of the centrosomes.

Besides emphasizing the part played by the cell periphery the author, by ingenious contrivances, estimates the amount that this periphery must grow or enlarge during cell division and here again seeks to bring in the assumed nuclear loss of liquid as a factor in the new formation of cell surface.

Though in the main adopting much of the conception of Heidenhain as to the part played by a system of contractile elements, the author does not suppose these elements are persistent cell structures handed on from one cell to another to do the work of cell division. Moreover he does not regard such radiations, when they are present, as anything like muscle fibrils but merely as indications of a rapid extraction of liquid leading to linear arrangements of vesicles and indicating lines of pulling force.

Continuity of Cells in Eggs.—August Hammar of Upsala having previously found[5] that the cells of cleaving eggs of echinoderms are connected by a superficial film of material, presumably protoplasm, has extended his observation and now claims that such intercellular con-

[5] See AMERICAN NATURALIST, July, 1896, p. 597.

nections are of universal occurrence. In the present paper[6] he describes and figures thin lines connecting the outer ends of *all* the cells of the cleavage and blastula stages of eggs from the following groups; Cœlenterates; Annelids; Mollusca; Tunicates; Mammals; Arthropods.

In life each cells has a faint outer periphery that is clearer than the rest; but it is only in sections that this layer, now seen as a stained line, passes over from one cell to the next so that the outermost contour of the entire egg is one continuous line of material.

In his method of preparation the cells split apart save for this peripheral line which thus becomes evident.

The author assumes that this connecting membrane is protoplasm, but it is unfortunate that he has no observations on living material to support this important claim and considering the remarkable effects often brought about by fixatives the question as to the true nature of this intercellular communication may well remain an open one. But the possibility that these connections may prove to be of similar nature to those described in the "spinning" of echinoderm eggs (AMERICAN NATURALIST, March, 1897) seems to the reviewer to add much to the probability that they are actual connections in the living egg.

From the author's point of view the blastula is one mass of protoplasm with a hole in the centre of it. He also points out the importance of the surface connection as a mechanical band; in fact he would ascribe to this many of the effects often attributed to surface tension of the individual cells. But regarding the connection as protoplasmic he emphasizes its importance as a *living* band and indicates its value as a basis for some of the assumptions of experimental embryologists as well as for the criticism of the cell theory by Whitman and by Sedgwick.

PSYCHOLOGY.[7]

Notes on Child Psychology—*Some Recent Literature.*—The past year has been one of remarkable activity in the sphere of Child Psychology everywhere, but especially in this country. *The Child-Study Monthly*, which was started in 1895, has published several articles of real value to the scientific investigator. The *Pedagogical Seminary* has been established upon a firmer footing. *Education, The Inland Educator, The Northwestern Journal of Education*, and other

[6] Archiv f. Mik. Anat. März 4, 1897, pps. 92–102, pl. 6.

[7] Edited by H. C. Warren, Princeton University, Princeton, N. J.

educational journals have devoted considerable space to child study. The works of Prof. Baldwin (*Mental Development in the Child and the Race*) and Miss Shinn (*Notes on the Development of a Child*) belong to the previous year; but two new studies of individual child development have appeared within the past twelve months. Mrs. K. C. Moore's monograph (*Mental Development of a Child*) is a very full record of the growth of her own child during its first two years; the author shows considerable judgment in her selection of material, as well as in its classification and discussion. Mrs. W. S. Hall has a similar study in hand, in a series of articles in the *Child-Study Monthly*, entitled *The First Five Hundred Days of a Child's Life;* five papers have already appeared; they are thorough and extremely suggestive. In connection with the statistical method, Dr. J. W. David, of Warsaw, reported at the Psychological Congress the results of a syllabus on the growth of ideas in children; he compared these results (on Polish children) with similar studies by other investigators in Germany and America. Mr. J. C. Shaw gives in the *Pedagogical Seminary* a statistical test of memory in school children. Prof. Sully's *Studies of Childhood,* while not statistical in method, contains a fund of material, new and old, on almost every topic of child study. Besides these general works, valuable contributions have been made by other writers to various branches of child psychology during the year.

Language.—It is interesting to compare the observations of Mrs. Moore (M) and Mrs. Hall (H) regarding the child's progress in learning to speak. The first sound observed by M was the short *a* uttered in crying; other sounds were made from the 36th day on, and ten days later responsive sounds were habitually made. No record was kept by H of the earliest babbling, except that the child began about the 47th day to "talk back" with the word "goo." H noted a distinction between the cries of hunger, pain, impatience and appeal by the ninth week, to which a cry of pleasure was added in the eleventh week. M noted different sounds for hunger and distress in the 12th week; these became real words by the 29th week. H observed the lip-movements corresponding to the words "mama," "papa" and "bye-bye" in the 32th week. The child's spoken words were first associated by him with definite objects in the 42nd week in both cases. The growth of vocabulary differed somewhat in form and rapidity. H records 3 words learned at the end of the 10th month, and 12, 24, 38, 58, 106, 199, at the end of the succeeding months; at the end of the 500 days the child was familiar with 232 words. M does not mention the progress by

months, but records a vocabulary of 5 words at the end of the 12th month, 384 in the 22d, and 570 in the 24th.

Nouns and interjections were in each case the first parts of speech used: the verb appeared next, in the 11th (H) and 16th (M) months. Since the number of interjections (acquired first, H) remained practically stationary, while the nouns increased rapidly, and since the number of verbs began to increase rapidly only during the 16th month (from 8 to 28 in this month, H), the difference between the two cases is not so great as might appear. If we bracket together (1) nouns and interjections, (2) verbs, (3) adjectives and adverbs, and (4) prepositions, pronouns and conjunctions, the order of acquisition of the parts of speech was the same. The order of relative importance, according to H, at the end of the 17th month, was (1) nouns, (2) verbs, (3) adjectives, (4) adverbs, prepositions and interjections (equal), (5) pronouns, etc.; the same order is given by M at the end of the 24th month, excepting that pronouns had risen to fourth place.

The first sentence (in each case, "Papa, gone,") was formed in the 48th (H) and 66th (M) weeks respectively. The interrogative form appeared in the 69th week (H), and between the 66th and 79th weeks (M). As one record closes with the 72nd week, it is impossible to follow the progress further in this direction.

The comparison of these records suggests the desirability of a more uniform classification of data, as well as the need of extreme care in interpreting them.

Drawing.—One number of the *University of California Studies* is devoted to four studies, by careful observers, of the progress of individual children in learning to draw. Prof. E. E. Brown summarizes the results in a supplementary paper. In the first stage (scribbling), he finds the chief element to consist in the pleasure in producing (making marks, changes); the interest is in the *process* rather than the product. Later, comes the notion of *representing* something; there is now a mingling of visual with the earlier motor images; the latter predominate at first, but in the course of time the visual picture comes to control the motor presentation. These observations, says Prof. Brown, agree with those of Prof. Baldwin, except that in the California investigations the children were generally not provided with a copy, and the advance was consequently not so rapid. Prof. Brown is unable to set any time for the first appearance of tracery imitation, and believes that this idea must be present in some dim form from the start. He emphasizes the importance of imitation as a stimulus to drawing, as well as an aid to progress in the art.

In the *Pedagogical Seminary* for October, Prof. H. T. Lukens contributes an interesting series of drawings by several children, beginning with the earliest attempts, at two years three months of age. He suggests a classification of the progressive steps in learning to draw, parallel to those in learning to speak. In language: I. Automatic cries and reflex or impulsive sounds. II. Imitation of sounds, but without meaning (babbling). III. Understanding of words, but no speaking beyond "mama," "papa," "no," etc. IV. Repetition of words as mere sounds. V. Use of words to express thoughts. VI. Study of grammar and rhetoric. In drawing the corresponding stages are: I. Automatic scribbling. II. Scribbling localizations and imitation of movements of other person's hands. III. Understanding of pictures; only simplest localization of features, by scribbling. IV. Copying from others to see how to get the right effect in the use of lines. V. Picture writing, illustrated stories, etc. VI. Study of technique; perspective, proportion, shading, etc. The central point, however, in the development of drawing, according to Prof. Lukens, is the elimination of scribbling and simplification of the drawings into a few telling lines.

Prof. Sully discusses children's drawings at considerable length in his book, and reproduces a large number of attempts to draw a man. These drawings are mostly of a comparatively late period of development, and show the growth of the ideas of features, proportion, relation of full face to profile, etc.; the earlier scribbling is scarcely touched on. Prof. Sully gives three stages of progress in drawing: (1) vague, formless scribble; (2) primitive design; (3) a more sophisticated treatment of the human figure.

The observations of Mrs. Moore and Mrs. Hall close with the 17th and 24th months, a period too early to furnish any data on the subject of drawing.

Intellectual Work and Fatigue.—Two interesting papers on this subject were read at the Psychological Congress. Prof. Ebbinghaus reported a series of tests on school children, in which it was sought to determine the relative capacity of different ages and sexes for intellectual work, as well as the effects of fatigue. Dr. J. Friedrich's paper, since published in full in the *Zeitschrift f. Psychologie*, gave tests of a single school class at intervals of an hour during the entire school day. The methods used by the two observers were different. Prof. Ebbinghaus used three tests. 1. *Calculation.* The method of Burgerstein was employed; pairs of figures were given to add and multiply, and the number of such operations completed in ten minutes was taken as test. 2. *Memory.* A series of figures was dictated rhythmically, and after

the list was read the subject wrote the numbers down as he remembered them. The series consisted of from 6 to 10 figures. The number of errors was taken as inverse measure of memory capacity. 3. *Combination.* Prose sentences were given (in writing), with words, syllables and groups of letters here and there omitted; the pupil was told to fill in the omissions. The number of syllables supplied within five minutes and the number of errors made in filling in were both taken into account. (The latter is open to criticism, since a false filling in of the text might, in certain cases, make as good sense as the original.) Prof. Ebbinghaus's tests were made on 15 classes of boys and 11 of girls of all grades; the same hours and days of the week were used in every case. The results showed in general an increase in exactness and capacity for work, corresponding to the increase in average age of the class; but this was subject to individual variations, a lower class being in some cases better than the next higher, although about a year younger on the average. The Combination method gave greater differences according to age than the Calculation method; the Memory method, in the application of which the individuality of the instructor played considerable part, showed irregular results. Dividing each class into three parts, according to scholarship, the methods gave quite different results. The memory tests showed no marked difference between good and bad scholars—if anything, it favored the latter; calculation showed a slight decrease from higher to lower; the combination tests, on the other hand, showed a marked difference in favor of the better scholars, as regards both the number of syllables supplied and the freedom from error. Comparing boys with girls, the latter were found to be inferior in the lower classes, but were somewhat superior in the highest classes; from which was argued a more rapid mental development among girls from the 12th to the 15th year. As to fatigue, the results agreed in general with those of Burgerstein and Laser. The capacity for work increased steadily to about the end of the third school hour, and then decreased somewhat, rising sometimes at the end of the school day. But the number of errors increased steadily throughout from the start.

Dr. Friedrich employed two methods in his tests. 1. *Dictation.* Twelve sentences were given, of about the same number of letters and signs, and about the same degree of difficulty. 2. *Calculation.* This consisted of five sums of two 20-place numbers, and five multiplications of 20-place by 1-place numbers. Each test was made at the beginning of the school day and at intervals of one hour. Some days a recess of 8 or 15 minutes was allowed between the hours, on others the lessons

following without intervening rest. Comparing the two cases, it was found that the intellectual capacity of the scholar diminished as the length of the lesson increased. The recesses proven efficient in remedying this, especially the longer intervals of 15 minutes. The author concludes that the one-hour lesson period is too long for the best results, and that a recess of at least 10 minutes should be allowed between each period.

Fear.—Prof. Binet's study of Fear in the *Annèe Psychologique* has already been noted in these pages. Stanley Hall treats the same subject exhaustively in a recent number of the *American Journal of Psychology.* Of 1,701 individual cases which he reports, nearly all are minors. 6,456 separate causes of fear are recorded: thunder and lightning was feared by the greatest number, 603; reptiles (483), strange persons (436), and darkness (432) follow next; then fire (365), death (299), domestic animals (268), disease (241), wild animals (206), water (205), insects (203), ghosts (203), rats and mice (199); a large number of other causes were confined to a few individuals. This classification is, perhaps, too minute for practical use. Combining the causes into larger classes, animals are found to be the cause of fear in 1,486 cases, celestial phenomena in 996, ghosts, etc., in 799, fire, water and drowning in 627, persons in 589, death or disease in 540. Pres. Hall points out the deep rooting of fears in human nature, and insists that the investigator must go far back in the organic series to reach any satisfactory ground for explanation.—H. C. W.

On the Effect of Music on Caged Animals.—Some time ago the writer was induced to experiment upon the animals in the Zoological Garden in Lincoln Park, with respect to the effect of music upon them, and the result may be of some interest to others working on psychological lines. The experiments were made at 6 o'clock P. M., two hours after feeding, and the instrument used was a violin.

Felis concolor Linné. Puma Panther. When the music first began two specimens of this species were resting in the back of the cage half asleep. At the first sound of the violin they started up, and could not for a time locate the sound, the writer being some distance from the cage. They showed, however, that they liked the sound, and when the player came as close as he could to the cage, they manifested their appreciation by lying down at full length and placing their heads between their paws. During this time the music had been of slow and sweet pieces, such as "Home, Sweet Home," "Annie Laurie," etc., etc. Suddenly, the player changed "Home, Sweet Home" to the "Irish

washer-woman." At this change the panthers worked their tails nervously, and twitched their ears, and as it was kept up for a time, they got up and began pacing up and down the cage. From this action the writer judged that either the jig music, being sharp and piercing, hurt their ears, or that it was distasteful. After playing several jigs of this kind the player again relapsed into soft strains, when the animals slowly settled down in their old positions.

Felis onca Linné. Jaguar. This animal behaved much as did the panthers. While the jigs were being played he acted in a very nervous manner, jumping from a shelf to the floor of the cage and back again. Soft music seemed to quiet him. As the writer was leaving the jaguar's cage, having ceased playing for the time being, the animal walked up to the corner and reached out with his paw toward the player as far as he could. Whether this action was intended to call the player back, or was simply done to catch hold of him, as many animals will do if a person gets too near to the cage, the writer cannot say. It was a curious fact that when the paw was extended the claws were all *retracted*.

Felis leopardus Linné. Leopard. Two specimens of this species did not seem to notice the music to any extent, except at first, as a matter of curiosity.

Felis leo Linné. Lion. The lioness Juno, with her three cubs, occupied a large cage and the player's attention was next directed to these. While the music was being played to the other animals the lioness and cubs had been listening and watching, the cubs playing about their mother's haunches. As the violinist drew near the cage the cubs scampered behind their parent, the latter greeting the player with a gentle hiss As the music struck up a lively jig the cubs stood upon their hind legs and peeped at the player over her haunches. They appeared very curious and much puzzled, hearing these sounds for the first time. Desiring to test their appreciation, the player slowly backed away from the cage, playing all the time; as he retreated, the cubs gradually came to the front of the cage, and the mother crawled to the front and placed her two fore-paws between the bars and stuck her nose through as far as she could. After retiring to the side of the hall the player again moved toward the cage, but the family did not move, nor evidence any displeasure when he came very close to them, in fact, so close that he almost touched the great paws of the lioness. As he played the soft strains of "Home, Sweet Home" the cubs and mother sat motionless. in rapt attention, the former turning their heads from side to side. A jig played very rapidly caused the cubs to prance about in a lively manner.

Felis tigris Buff. Bengal Tiger. The music had a peculiar effect on the pair of animals in this cage. The male paid absolutely no attention to it, save glancing in the direction of the player and giving a vicious snarl. The female, however, acted as though she liked it, for she jumped upon a shelf and placed her paws and nose through the bars as described under the last species. A second experiment with the male, later, when he was stretched out upon the floor of the cage, caused him simply to look at the player, twitch his ears, and viciously spit and snarl at him. The female, however, on all occasions showed that music was not distasteful to her and that it was, on the whole, pleasing.

Hyena vulgaris Buff. Hyena. This animal is probably the most cowardly of all the mammals, and the only effect which music had upon two individuals was to cause them to retreat to the farther end of the cage and try to squeeze out between the bars. A lively jig frightened them nearly to death, and made them tremble in every limb. Strange to say, however, they did not howl or make the least noise.

Quadrumana. The Monkeys. (Genus *Cynocephalus.*) The monkeys evidenced great curiosity at the music, but did not seem to show either pleasure or displeasure at the sounds. A South American Sooty Mangabey, however, seemed to be rather pleased with the strains, particularly the jigs. This animal is of a quarrelsome disposition, and is therefore kept separate from the other monkeys. It was thought by Mr. Sweeney, the keeper, that the sounds might awaken a feeling of anger in him, but such was not the case. As the violinist drew away, he followed as far as his cage would allow. A spark of reason was observed in this animal. His cage is of glass all around, and in order to hear the music better he placed his ear to a crack in the door. This he did several times as the player drew near or went farther from the cage. The monkeys confined in the larger cage, also of glass, formed themselves in a broken semi-circle about that part of the cage nearest the violinist, and looked at him in apparent wonder. As he moved away from them, they arose from their sitting posture with one accord and followed him along the side of the cage. This was probably simply curiosity, although the music may have given them some pleasurable sensations. On the whole, the monkeys did not show as much intelligence as might have been expected from their high position in the scale of nature.

Pilecanus fuscus Linné and *P. erythrorhynchus* Gm. Brown and White Pelicans. The pen containing these birds is situated next to the monkey cage, and the music was next tried upon them. The effect was somewhat startling, for they all began to jump about, flap their wings, and snap their huge beaks; this might, perhaps, be called dancing.

When the violinist drew near the cage they snapped at him with their beaks.

The other birds in the animal house paid very little attention to the music, partly, perhaps, because they were sleepy. Several varieties of parrots, herons and smaller birds were tried in turn, but without producing any results worthy of mention.

Canis latrans Say. Coyote. The last experiment tried was upon a den of coyotes in the park. When the playing began all the animals were in their holes, but the first note had hardly been struck when they came running out, and raced up and down their den until they had located the sounds. When this was done they all squatted in a semi-circle about the violinist, he having approached the bars of the den as near as possible, and sat in silence listening to the music. When it ceased they ran up to the player and pawed at him through the bars, indicating as plainly as possible that they wished to hear more. When he began to play again they again silently formed in a semi-circle. This experiment was tried a number of times, but always with the same result. During this time not a sound was uttered by the coyotes, but a wolf in the den adjoining howled lustily. Here, as in the other cases, soft, sweet music seemed to be better appreciated than loud, harsh music.

Besides music made up of regular pieces, all sorts of sounds were made by the violinist—screeches, piercing notes, imitations of a cat, cow-rooster crowing and pig squealing, but these did not seem to have much effect. The loud, harsh and piercing notes seemed to affect their ears, for they moved them about nervously as though the noise hurt the sensitive nerves. To sum up general impressions, slow and soft music was received, as a rule, with more signs of pleasure than the lively jigs. The females, also, seemed to pay more attention to the music, and to be more pleased with it, than were the males. The nocturnal mammals were more interested than were the diurnal birds. This was probably due to the fact that the experiment was tried after dark, when the animal house was lighted only by electricity. It was a curious and interesting fact that the whole performance was conducted without any noise other than an occasional grunt from the lions. The experiment is worthy of repetition, and should be made at different times during the day, as in the early morning and at noon, just before and after feeding, etc., to see whether or not these conditions have any effect upon the result. The writer is convinced that many interesting and valuable facts may be learned by experiments of this character.

—Frank Collins Baker.

MICROSCOPY.

The Proper Angle for the Razor in Paraffin Sectioning.—In a discussion between Dr. M. Heidenhain and Dr. B. Rawitz relative to section cutting and the staining of microscopic preparations, the latter person[1] upholds the advice that he gave in his "Leitfaden," and adduces experimental proof to show that the microtome knife should be placed at an acute angle to the stroke rather than at a right angle. When placed at the latter angle the sections according to their thickness, are always more or less crowded together, thus distorting the finer structures of the tissue cut. The experimental proof consists of the measurement of sections cut with the knife at a right angle, and with it at an angle of 45°. The sections were from a block of paraffin measuring $20\frac{1}{2} \times 11\frac{1}{2}$ mm., and had a thickness of 15μ, 10μ and 5μ. With the knife at the acute angle they all measured 11 mm. in breadth, while with the knife at a right angle they measured $9\frac{1}{2}$ mm. for the 15μ, 9 mm. for the 10μ, and 8 mm. for the 5μ sections, thus showing a shrinkage of 2, $2\frac{1}{2}$, and $3\frac{1}{2}$ mm. respectively. In the case of the thinnest sections there is a loss in breadth of almost a third of the surface of the block, and such are somewhat incorrectly denominated 'sections'. They might be called "Quetschen."—F. C. Kenyon.

Formol, not Formal.—The paper by Bert B. Stroud in the January number of this Journal, induces me to make a few remarks regarding the nomenclature of the method of hardening by formol introduced by me into histological technique. Though I agree with the author that the terms formalin and formalose are bad and meaningless, I cannot agree to the objection to the denomination of the original fluid as "formol." To call the solution by the name of formaldehyde is not to be recommended, as formaldehyde, C_2HO, is a gas. The term formol is opposed by Stroud because the terminal syllable "ol" suggests an alcohol; but formaldehyde dissolved in water is no longer to be regarded as an aldehyde, but as a double alcohol, methylenglycol.

$$\genfrac{}{}{0pt}{}{H}{H}\!\!>\!C\text{—}O=\text{Formaldehyd.}$$

$$CH_2O+H_2O=\genfrac{}{}{0pt}{}{H}{H}\!\!>\!C\!<\!\!\genfrac{}{}{0pt}{}{OH}{OH}=\text{Methylenglycol.}$$

[1] Bemerkungen über Mikrotomschneiden und über das Färben mikroskopischer Präparate. Anat. Anz. XIII, 65–80. Separat from the author.

Another reason for naming the original fluid "formol" might be that this is the oldest name for the watery solution of formaldehyde (Trillas) and that on its introduction into microscopic and preserving technique by my father and myself it was called "formol."

The law of priority therefor supports "formol."

The term "formal" is suited only to increase confusion.

In regard to Stroud's observations which are often contradictory of those of European workers—which he seems to have overlooked—I wish to remark that the behavior of formol towards egg albumen was a long while ago thoroughly studied by me, and that in a series of publications I have demonstrated that egg or sero albumen is not only not coagulated by formol, but on the contrary is, in a sense, rendered more fluid, since a compound, methylen-albumen, is formed that never coagulates even upon the solution being heated. This non-coagulating methylen-albumen I have designated "protogen," and have described its behavior in the test tube as well as in the organism.

To avoid the bad effect of formol on some tissues, which Stroud describes, it is only necessary to employ a more concentrated solution. To the 10 per cent. (formol 1., water 9) solution originally recommended by me a small addition of alcohol may sometimes be made advantageously.—Dr. F. Blum.

The Name of Formal.—To the Editor.—In answer to "A Protest," on pp. 267–268 of the March, 1897, number of The American Naturalist, against my use of the terms Formal, etc., as given in the January number, if "A Comparative Anatomist" will consult an elementary text-book on Organic Chemistry he will learn:

1. That there is a good precedent for applying the term *Formal* to the compound H–CHO, and the very best authority for applying the suffix *-al* to any aldehyde, *e. g.*, *Chloral* CCl_3.CHO, Trichloracetic aldehyde, etc.

2. That the very example he quotes disproves the point he seeks to make.

The term *acetal* is derived "from *acetic* and *aldehyde* (Foster's Encyclopædic Medical Dictionary, Vol. I, p. 22). In the article, "Chemical Nomenclature," Dictionary of Chemistry, by Henry Watts, London, 1866, Vol. IV, p. 133, this statement occurs: "*-al* abbreviation of *aldehyde*. *Ex.* Butyral=Butyric aldehyde; Valeral=Valeric aldehyde." To this it may be added that the highest authority in the world, namely, The Geneva Congress of Chemists, adopted the following: "Resolution 32. Aldehydes will be designated by the suffix *-al* (*Me-*

thanal, Ethanal)." (See abstract of their proceedings in *The American Chemical Journal*, Vol. 15, 1893, p. 58.) In view of the action of this Congress, the term *Methanal* would be the preferable one. But the term *Formal* is equally correct, and less likely to trouble persons already familiar with the substance.[2]

The writer's aim was to avoid confusion by the use of a term short, convenient, and correct; and he insists that *Formal* fulfils these requirements.

Respecting the strictly anatomic terms, "Comparative Anatomist" is referred to the article, "Neural Terms, International and National," in the last number of the *Journal of Comparative Neurology*. *Axon* was proposed in 1884 for the skeletal axis, whether a membranous tube, a cartilaginous rod, or a series of osseous vertebral centrums. *Alba* could hardly be mistaken for anything but *substantia alba*. *Tela* readily, if not inevitably, suggests the *tela vasculosa* of Huxley (*Zoological Proceedings*, 1876, p. 30), and the *tela chorioidea ventriculi* of Schwalbe's "Neurologie" (pp. 404 and 464), and the Report of the Nomenclatur Commission of the Anatomische Gesellschaft, 1895. All three terms are defined in recent English and medical dictionaries. Is not "Comparative Anatomist" needlessly magnifying his difficulties?—B. B. STROUD.

Ithaca, N. Y., March 13, 1897.

Formol or Formalin.—With reference to the present discussion over the proper name to be used for the 40 per cent. aqueous solution of formaldehyde, it may be said that had the author of the criticised paper that appeared in the January number looked up the chemical side of the question more carefully he would have found that there is another and much stronger reason for not using the term that he suggests than the very good one of priority, or the equally good one referring to the condition of the dissolved gas, cited by Dr. Blum. Had he read the account of formaldehyde given by Ladenburg in his "Handwörterbuch der Chemie" (Breslau, 1882), Vol. 1, on page. 195, paragraph 2, he would have found the following:

"Zu den sogen. Acetalen (Vergl., pag. 191) des Methylen-oxydes, welche als Alkoholäther der Aldehyde aufzufassen sind, gehören das Methylal oder *Formal*, CH_2 $(O. CH_3)_2$, Methyläther, und der Methylendiäther, CH_2 $(O. CH_5)_2$." The italics are mine.—F. C. KENYON.

[2] As has been previously stated, (This Journal, January, 1897, p. 92) confusion has arisen from the indiscriminate use, by various writers, of the terms *Formalin*, *Formalose*, and *Formol*.

Correction—Foot note 1, p. 92, should read "——*Formal* from *Formaldehyde*, is a good scientific contraction".

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Boston Society of Natural History.—The general meeting was held Wednesday evening, April 7, 1897.—The following papers were read: Prof. J. Eliot Wolff, "The occurrence of Tourmalines at Mt. Mica, Paris, Me.;" Dr. C. B. Davenport, "The rôle of water in growth." Wednesday evening, April 21, 1897.—The following paper was read: Mr. Herbert Lyon Jones, "Some biological adaptations of our seaside plants." Stereopticon views were shown.—SAMUEL HENSHAW, *Secretary.*

New York Academy of Sciences.—Biological Section.—March 8, 1897.—The papers presented were: H. E. Crampton, "On the Ascidian Half Embryo." His experimental studies on the egg of *Molgula manhattensis* showed that the isolated blastomeres segment in a strictly 'partial' manner, but that a gradual passage to a total development ensues. As far as the early stages were concerned Chabry, Roux, Barfurth are entirely correct in arguing for a half or 'partial' development. But Driesch, Hertwig and others are also correct in considering the end results a 'total' larva of less than the normal size. The paper will be published in full.

N. R. Harrington, "On a Nereid from Puget Sound (Pacific Coast) which lives commensally with the Hermit crab, *Eupagurus alaskensis.* A variety of the Western European species *N. fucata* is known to inhabit deserted whelk shells with *Eupagurus bernhardus* and a careful comparison of the Old and the New World forms brings out resemblances in structure due to the operation of the same physiological factors. These are notably (1) the degeneration of the muscular and cuticular layers in the posterior two-thirds of the body, (2) loss of the pigment in the same, (3) physiological factors may explain why only females have been found (as yet) in this comfortable and nutritive habitat. The author surmises that the commensal form is the female Epitocous type of some free living nereid.

This apparently undescribed species from the Pacific differs from *N. fucata, B. inquilina* of Wirèn in the arrangement of the paragnathi, respiratory lobes of notopodium and transverse pigment stripes.

Bashford Dean, "A Posthumous Memoir of Prof. J. S. Newberry. This paper described new species and a new genus of North American fossil fishes, and discussed the genera Oracanthus, Dactylodus, Polyrhizodus, Sandalodus, and Petalodus.

Among the types were species of Cladodus, Oracanthus, Ctenacanthus, Stettacanthus, Asteroptychius, Dactylodus, Deltodus, Sandalodus, Psephodus, Heliodus, Ctenodus. *Dinichthys corrugatus* was taken as a type of a new genus Stenognathus.

At the conclusion of the papers, an election of sectional officers was held. Prof. E. B. Wilson was elected chairman for the ensuing year, Prof. C. L. Bristol, Secretary.—BASHFORD DEAN, *Secretary.*

New York Academy of Sciences.—Section of Geology.—March 15, 1897.—The first communication of the evening was by Mr. Hienrich Ries entitled "Mineralogical Notes." Mr. Ries spoke of some Allanite crystals with new faces; also of some large crystals of fibrous gypsum from Newcastle, Wyoming; also exhibited some large Childrenite crystals from Maine and some Amphibole crystals with many terminal faces from Virginia. He also spoke of some Pseudomorphs of gold after Sylvenite from Cripple Creek, Colorado, The finding of a new Beryl crystal with an unusually large number of terminal faces in New York City was also noted.

The second paper of the evening was written by Mr. Herbert Bolton, entitled "The Lancashire Coal Field of England" and read in abstract by President Stevenson. The paper spoke of the geographic conditions of the Lancashire coal field and its neighborhood, of the extent and quality of the coal and of the age of the structural movements which had caused the present geological characteristics in the coal area. A careful correlation was made between the coal measures of this field and the deposits of the United States. Distribution of the fauna and flora and their character was taken up in some detail and it was shown that in the lower coal measures the life is mostly marine, in the middle coal measures of fresh and brackish origin, and in the upper coal measures that the fauna was scarce. When published this paper will be a valuable contribution to the literature of coals and will be of great assistance to workers in America in their endeavors to correlate the deposits on the two side of the water.

The third paper of the evening was by Stuart Weller, of Chicago University, entitled "The Batesville Sandstone of Arkansas," abstracted by Mr. Gilbert Van Ingen. The paper entered into some detail regarding the Batesville section and the fauna of the Batesville sandstone in that section. Of the invertebrates thirty species have been found, of which eleven point to the St. Louis age of the sandstone, six to the Kaskaskia age, while thirteen are of indeterminate value. On account of the greater abundance of the numbers of specimens of the

second group and from stratigraphic evidence as well, it is probable that the sandstone belongs in the base of the Kaskaskia group and is the same as the Aux Vasa limestone of Southern Illinois. This paper gives the data wherein to correlate the Mississippian section with the section about the Ozark Hills.—April 19, 1897.—The evening of the monthly meeting of the Section was devoted to a reception by the whole Academy to Sir Archibald Geikie, Director-General of H. M. Geological Survey of Great Britian, who has just returned to this country for a brief visit after an absence of eighteen years. After an informal reception the meeting was called to order and addressed briefly by the President of the Academy, Prof. J. J. Stevenson, who extended a most hearty welcome from the scientists of New York to the guest of the evening. Prof. Stevenson was followed by Prof. J. F. Kemp, the Chairman of the Section, who reviewed in a few words the greater contributions of Sir Archibald Geikie to the cause of Geology. He spoke of his early work in Scotland, in France and in the Western United States in the study of vulcanism, and paid particular attention to the work that had been done in Scotland on the metamorphic rocks. Prof. Kemp concluded with a tribute to Sir. Archibald as a naturalist and spoke of the superior quality of work that is given the world by the man who is in love with nature and finds in the solitude of the wildness of nature his greatest company and inspiration.

The next speaker was the Secretary of the Section who spoke particularly of the work of Sir Archibald Geikie as looked at from the standpoint of the teacher and physiographer. He reviewed hastily the character and quality of Geikie's Text Book and Class Book of Geology and spoke more especially of the example this distinguished geologist has set in physiography in the masterly analysis of the physical features of Scotland given in his Scenery of Scotland.

The last address of welcome was given by Prof. Angelo Heilprin of Philadelphia who spoke as a traveler and contrasted the knowledge of the geology of the world now with our knowledge at the time of Humboldt. He spoke of how much we owed to the guest we were welcoming for his work in bringing together the shreds of knowledge from all parts of the world and in building up a great mass of geological information, which is a vast help to all workers in geology and a stimulus to all.

In reply Sir Archibald Geikie expressed his thanks to the Academy for the very cordial reception that had been tendered him in New York. He contrasted the appearance of the city eighteen years ago and now, and spoke of the great growth of New York vertically as well

as horizontally. He paid a brief word of tribute to his friends of his former visit, particularly Newberry, Leidy, Dana, Cope and Hayden, whose help and good will have ever been a great inspiration to him.

In reviewing the work of world wide reputation that the American geologists are producing, Sir Archibald Geikie paid a warm tribute to their industry, their perseverance, their breadth and to their scientific acuteness. He contrasted in a very favorable way to the United States the policy of the British and United States Governments in regard to the printing, publishing and distribution of government reports.

After these brief addresses an opportunity was given for meeting the guest of the evening for personal social meetings among the members of the Academy, and for greeting the guests from a distance including several well known geologists.—RICHARD E. DODGE, *Secretary.*

Torrey Botanical Club.—At the regular meeting of Feb. 9th, about 200 persons present, the scientific program consisted of a lecture by Mr. Henry A. Siebrecht, entitled "Orchids, their habitat, manner of collecting and Cultivation"; handsomely illustrated with lantern-slides by Mr. Cornelius Van Brunt, colored by Mrs. Van Brunt.

Mr. Siebrecht in his paper referred to the hardships undergone by the orchid-collector, and paid a tribute to the energy displayed by three friends of the speaker, Carmiole, an Italian, who had come to New York when the speaker was a boy; Föstermann, who died about two years ago, the victim, like most collectors, of disease contracted in that enterprise; and Thieme, who had made three trips for Mr. Siebrecht, and who went last to Brazil in search of the *Cattleya autumnalis* but was never heard from.

Mr. Siebrecht referred also to three trips of his own in quest of orchids, to the West Indies, Venezuela, Brazil and Central America. He then exhibited the lantern views, which were of remarkable beauty and evoked frequent applause. They included numerous representatives of the chief tropical genera cultivated, also with views of interiors showing the Cattleys house in full blossom, etc. Slides showing numerous species native to the Eastern United States, followed.

Mr. Siebrecht then described the culture of orchids and classed their diseases, as chiefly because too wet, when the "spot" closes the stomata, or too dry, when they collect insects. He referred to their insect enemies at home, the "Jack-Spaniard" which eats the marrow from the bulb, and the Cattleya-fly, now introduced into English houses. He mentioned the ravages of *Cladosporium*, and the great difficulty with which orchids of the genus *Phalœnopsis* are preserved from fungal diseases.

The subject was further discussed by the President, Dr. Britton, Mr. Samuel Henshaw, and Mr. Livingston, the latter referring to his recent experience as an orchid collector. A slide was exhibited, made from a photograph taken by Mr. Livingston showing his orchids packed upon oxen and so carried down from the mountains to Magdalena.

Mr. Henshaw spoke of his visit to Mr. Siebrecht's nursery in Trinidad, and of the growth made there by Crotons, as much in one year as here in four or five. In those gardens they divide their plants by rows and edges of Crotons which are sheared off as we would trim a privet-hedge. Mr. Henshaw also paid a deserved tribute to Mrs. Van Brunt for the wonderful success of their coloring of the orchid slides.

February 24, 1897.—The first paper was by Mr. Arthur Hollick, "A fossil *Arundo* from Staten Island."

This paper, which is to appear in the *Bulletin*, was presented by Dr. Britton, with prefatory remarks referring to this discovery. Its occurrence was in yellow sand of Staten Island belonging to late Tertiary or early Quaternary; the locality, a pit near Fort Wadsworth. The preliminary reference to *Phragmites* is now changed by Mr. Hollick to the tropical genus *Arundo*.

A paper followed by Mr. E. O. Wooten, "Remarks on some of the rarer Plants of New Mexico."

Mr. Wooton sketched briefly the botanical regions of New Mexico, dividing the territory by differences in the flora into (a) the river valleys, (b) the table-lands or *mesas*, (c) the dry, rocky and narrow mountain ranges, and (d) those areas which are of uniformly high altitude and have numerous mountain ranges closely associated and more or less timbered. He also traced upon a map the routes trasvered by most of the botanical collectors who have visited New Mexico, beginning with Pike and including Long, Gregg, Wislizenus in 1846, Emory, Marcy, Sitgreaves, and Woodhouse, with the work of the Mexican Boundary and other surveys, 1849 and after. Mr. Wooten was himself practically the first to make collections in the south-east section of the territory, a very interesting, botanical region, with high mountains, some of which were illustrated by photographs. Specimens of Mr. Wooton's collecting were then shown exhibiting about 35 flowering plants and ferns, and including among those familiar in the east, *Pellæa atropurpures*, *Cystopteris fragilis*, *Pteris aquilina* and *Cheilanthes tomentosa*.

Discussing Mr. Wooton's presentation, Dr. Rusby spoke of his own former travels in New Mexico, and of various incidents of that journey, as of the discovery of *Primula Parryi* on the top of Gray's Peak (cen-

tral Arizona) blooming on July 2d under three or four inches of snow which had just fallen.

Mr. Rydberg compared some of the features presented by the sand region of Central Nebraska; referred to *Muhlenbergia pungens* and other so-called "*blow-out grasses*" of the sand-hills; and described the formation of the characteristic "blow-outs" or hollows, originating in spots where the grasses had died out, and deepening rapidly, sometimes to 300 feet, producing a country where the hills are moving every year, and where when camping he could find no fuel except roots of sand-cheeries exposed along fresh "blow-outs."

Discussion by Dr. Allen, Mr. Wooton and Dr. Rusby followed relative to the loco-weed poison. Mr. Wooton said that species (formerly *Oxytropis*) *lamberti* is the chief *loco-weed* about Flagstaff (Arizona); that cattle men claim that the well fed animal will not touch it, but that those which have formed the taste will not eat anything else. Reasons were urged by the speakers for the belief that the results of the loco-weed are due simply to mal-nutrition, or to effect of seeds alone, or to a posion (as extracted by Sheldon) diffused in very minute quantities throughout the plant.

The next paper was by Dr. H. M. Richards of Barnard College, "On some of the Reactions of Plants toward Injury."

Dr. Richards spoke on certain effects of wounding upon the functions of various plant organs as shown by his own experiments in Germany last summer. Diagrams illustrating the effect of injury upon both respiration and temperature were shown. In the former case it was seen that the respiration is greatly increased by wounding, attaining its maximum about 24 hours after the injury was inflicted; this increase depending both on the stimulus of the wound itself and upon the access of atmospheric oxygen to the tissues. The occurrence of a corresponding rise in temperature, of a local nature, was also briefly referred to; the temperature curve corresponding closely to that described by the increased respiratory activity. The thermœlectric apparatus used was described; its delicacy is such as to indicate a difference of $\frac{1}{400}$ of a degree; the result with potatoes showing a maximum rise of temperature of a little over $\frac{2}{10}$ of a degree at the end of the second day, falling to the end of the 5th day. A remarkable temperature rise in the onion of nearly $3\frac{1}{2}$ degrees was explained by the fact that here the rise was not local but affected the whole onion, in accordance with its morphological structure, and with the fact that metabolism is carried on very fast in the onion.

The paper was discussed by Dr. Jelliffe and by Dr. Britton, especially with regard to the sudden escape of CO_2 after wounding, Dr. Richards considering it to be due largely to contents of intercellular spaces, but partly to solution within the cells; potatoes contain a very considerable amount of enclosed CO_2, a quart of it being obtained from a pound of potatoes. Dr. Richards distinguished carefully the coincident but independent escape of a slight amount of CO_2 always given off, even in pure hydrogen; to be called "intermolecular respiration."

The next paper was a contribution read by title, from Dr. Alexander Zahlbrückner of Vienna, a corresponding member of the club, entitled, "Revisio Lobeliacearum Boliviensium hucusque cognitarum." The paper, which is in Latin, enumerates all the species, giving synonymy and references to the literature, and cites collectors and their numbers. There are 39 species, as follows: 9 in *Centropogon*, 2 new; 20 in *Siphocampylos*, 7 new; 1 in *Laurentia;* 2 in *Rhizocephalum;* 3 in *Hypsela;* 4 in *Lobelia*. The paper will be printed in the *Bulletin*.

Tuesday evening, March 9, 1897.—The evening was devoted to ferns with papers as follows:

1. Mrs. Elizabeth G. Britton, "Notes on some Mexican Ferns;" presented in Mrs. Britton's absence by Dr. Rusby, with exhibition of numerous specimens, including species of Pellæa, Polypodium, Cystopteris and Cheilanthes. Dr. Rusby, having been himself present at their collection, described vividly the tongue of hard, black lava on which the collectors walked, and which was filled with large cavities often forming caves, containing some accumulation of soil and crowded with a luxuriant growth of ferns although in November and practically the winter season.

2. Mr. Willard N. Clute, "The New York Stations for *Scolopandrium*." Mr. Clute contrasted the wide distribution of the Hart's tongue fern in the old world, from the Azores to Japan, with the extremely local North American occurrence, in five areas only, Mexico, Tennessee, Central New York, Owen Sound in Ontario, and New Brunswick. The Central New York locality was made known early in the present century through John Williamson, and was visited by Pursh in July, 1807, who found it five miles west of Syracuse on the farm of J. Geddes, where it has recently been rediscovered. About 1827, Wm. Cooper discovered it at Chittenango Falls where Mr. Clute found hundreds of plants growing last summer. Mr. Clute described the Chittenango ravine and its ferns. On sunny exposures of the limestone walls of the ravine grow rue spleenwort and purple cliff-brake in quanities; in shady places, the slender cliff-brake; on the talus, upon the larger bowlders,

the walking fern, and in the shade of these bowlders, the Scolopendrium, chiefly in clusters of 2 to 6, at first erect, finally somewhat drooping, and ripe in September. Mr. Clute added that the species seems to be increasing at present, being now under the protection of an association.

Prof. Burgess remarked upon the former scarcity of the fern in that locality as reported to him by Dr. Torrey of Chittenango about 1874, and by Dr. Morong who could find none at his visit about 1876.

Prof. Underwood spoke of the Jamesville locality, also on the corniferous limestone in Onondaga Co., where 20 years ago he found it quite common about two small lakes, but becoming soon exhausted at the one most frequently visited. He queried why it should not occur at other ledges of the corniferous limestone throughout Western New York, and why it should confine itself to that rock here while in England it frequents sandstone, shale and limestone indifferently. Dr. Britton then remarked that in Europe (and Nova Scotia) *Campanula rotundifolia* grows in meadows, but here on rocks; *Cerastium arvense* also grows in Europe in fields, but here on rocks.

Dr. Britton said that Scolopendrium is probably a case like that of Sequoia and Brasenia of originally much wider distribution, where the isolated plants owe their survival to favorable conditions. He cited Epipactis among orchids as a parallel in distribution, confined here to Central New York and Ontario, but wide-spread in the old world.

Mr. Benj. D. Gilbert added an interesting comparison of the growth of Scolopendrium at stations where he had collected it at Jamesville and Chittenango Falls, also in southern France, northern Italy, and Undercliff in the Isle of Wight. In the warm shelter of the latter place, it is more luxuriant than anywhere else, showing great tendency to sport, displaying forking tips and deeply cordate bases as at Chitenango Falls.

3. The third paper was by Mr. B. D. Gilbert, of Utica, N. Y., entitled, "New and interesting Ferns from Bolivia," with exhibition of specimens of two new ferns, *Blechnum nigro-squamatum* and *Nephrodium villosum inæquilaterale* Gilbert, the first peculiar in being fully pinnate, the second in being a one-sided dwarf persistently under a foot and a half high, instead of 4 or 5 feet as its type.

4. The fourth paper, also by Mr. Gilbert, "Jamaica, the Fern-Lover's Paradise, described the abundance of species and of individuals which the speaker had collected there, illustrating the subject by numerous specimens. He remarked that Swartz in his *Species filicum*, 1783–'86, enumerating all then known ferns, described 709 species; of which 149 were from Jamaica; the Jamaican number was raised to 300 by

Grisebach and now to 500 by resident botanists there, an estimate confirmed by Mr. Gilbert. Probably no other equal area produced half that number. Among reasons which account for this are the warm latitude of Jamaica, its south shore sheltered from color breezes by a mountain-wall, its mountains themselves rising to 7,000 feet and reaching into a cool temperate climate, and its great variation in moisture, with daily rains in the mountains and sometimes but twice in six months on the plain. Mr. Gilbert described in particular his experiences with the tree-ferns reached by a long journey on foot, high in the Blue Mountains, there forming unmixed groves, their stems supplying the only wood readily obtainable. One, *Alsophila armata*, reaches 50 feet in height, though its slender stem is but a few inches in diameter. No class of ferns is as yet so poorly described, as the tree-ferns; description should be from the living specimen and at the locality; the only such in English are those in Thwaites' Flora of Ceylon. Jamaica is remarkable in particular for its numerous Filmy Ferns, 26 species (out of 280 known); these are all in the three eastern parishes. In the east part *Blochnum occidentalis* is the common fern of the roadsides; *Polypodium reptans* was seen everywhere, now growing erect; one bank 30 x 25 feet was completely covered with *Gleichenia pectinacea*. The great number of endemic species is surprising; as if the work of differentiation had gone on there with greater activity and vital power than anywhere else in the world; every genus in Jamaica shows one or more endemic species.

Mr. Gilbert closed by exhibiting specimens of three new species from Jamaica, belonging to *Asplenium*, *Dryopteris* and *Polypodium*, and also of a number of rare species as *Entomosora campbellii*, *Gymnogramma schizophylla* and *Adiautum candollei*. His paper was discussed by President Brown, Prof. Underwood and Dr. Rusby, the latter referring to the uses made of tree-ferns in New Zealand, as compared with the use for timber and for posts in Jamaica.—EDWARD S. BURGESS, *Secretary*.

The Chicago Academy of Sciences.—The spring course of lectures for 1897 were as follows: March 12. Amelia Weed Holbrook, "*The Antiquity of (so-called) Modern Inventions.*" March 19. Alja Robinson Crook, Ph. D., Professor of Mineralogy and Petrology, Northwestern University. "*Some Geological Causes of the Scenery of Yellowstone National Park.*" Illustrated with stereopticon. March 26. Frank Collins Baker, B. S. Secretary and Curator, Chicago Academy of Sciences. "*The History of Creation as Revealed in the Rocks.*" In

this lecture, ideal landscapes and curious animals of prehistoric ages was shown by the stereopticon. April 2. A. W. Hitt, M. D. "*Leprosy, its Causes and Prevalence.*" Illustrated with stereopticon. This lecture was a popular talk upon this little known subject. April 9. Frank Collins Baker, B. S. "*Types of Animals.*" This lecture was a repetition by request, with some modifications, of the lecture given in February on the Evolution of Animals. The school children were particularly invited, as it was intended more for their instruction, than for the older members of the audience. April 16. H. H. Brown, M. D., Professor of Didactic and Clinic Ophthalmology, Illinois Medical College. "*The Eye.*"

The Biological Society of Washington.—The 274th regular meeting was held on Saturday evening, March 27, 1897, in the Assembly Hall of the Cosmos Club, after Brief Informal Notes and Exhibition of Specimens, the following communications were read: M. B. Waite, "Factors Governing Pear Blight"; Theo. Holm, "The Grass Embryo and its Constituents"; E. A. De Schweinitz, "Some Methods of Generating Formaldehyde and its use as a Disinfectant.—FREDERIC A. LUCAS, *Secretary.*

Anthropological Society of Washington.—The 263d Regular Meeting of the Society was held in the Assembly Hall of the Cosmos Club, on Tuesday, April 20. "Scopelism," Dr. Robert Fletcher; "Unusual Frequency of Wormian Bones in the Coronal Suture of Artifically Deformed Kwakiutl Crania," Mr. George A. Dorsey; "Measurements and Indices of the Long Bones of the Kwakiutl and Salish Indians," Mr. George A. Dorsey.—WESTON FLINT, *Secretary Board of Managers.*

N. S. I. S.—The Ordinary Monthly Meeting of the Nova Scotian Institute of Sciences were held in the Legislative Council Chamber, Province Building, Halifax, on Monday, the 12th of April. The following papers were read: "A Note on our Calcareous Algæ," by A. H. MacKay, Esq., LL. D., F. S. Sc., F. R. S. C. Superintendent of Education; "Zoological Notes," by Harry Piers, Esq.—HARRY PIERS, *Secretary.*

The Association of American Anatomists.—March 30, 1897. —The next meeting of this Association will be held in Washington city in connection with the Congress of American Physicans and Surgeons, Tuesday to Thursday, May 4 to 6, 1897.

The meetings of the Congress will be held in the Columbia Theater, corner of Twelfth and F Streets, N. W., from 2 to 5 P. M. daily. Those

of this Association accordingly will be held in the mornings, from 9 to 12.30, unless otherwise ordered by the Association, and in the Physical Laboratory of Columbian, University, corner Fifteenth and H. Streets, N. W.

The titles of but four papers have thus far been received, to wit: by Dr. Wilder, "Notes on the Biceps" and "The definite encephalic segments and their designation;" by Dr. Stroud, "Comparative anatomy of the cerebellum" and "On Brain Preservation;" all of them illustrated by specimens, photographs and charts.

Members who intend to read papers or present specimens will please send titles to the Secretary as soon as convenient, that they may appear on the printed program.

The statue of Prof. Samuel D. Gross will be dedicated during the Congress.

Blank forms of application for membership will be sent on application.—D. S. Lamb, *Secretary and Treasurer.*

The Academy of Science of St. Louis.—At the meeting of the Academy of Science of St. Louis held on the evening of April 5, 1897, Professor Frederic Starr, of the University of Chicago, briefly addressed the Academy on the functions of such organizations, with especial reference to the local problems. Mr. H. C. Irish presented a paper on the relations of the unfolding of plants in spring to meterorological conditions, in which were embodied deductions drawn from a series of observations made at the Missouri Botanical Garden, and those by other observers, extending back to the time of Stillingfleet, in the last century. Mr. Charles Robertson presented for publication a paper entitled North American Bees—Descriptions and Synonyms.—Wm. Trelease, *Secretary.*

The Botanical Seminar of the University of Nebraska.—February 27, 1897.—The Periodicity of Flowering, Mr. F. E. Clements; Herbaceous Vegetation-Forms, Mr. Roscoe Pound; The Karyology of the *Ascomycetes*; a Review, Mr. C. L. Shear; Organogeny of the Genus *Prunus*, Mr. A. T. Bell. March 27, 1897.—Chimney-shaped Stomata in Greatly-thickened Epidermis, Dr. C. E. Bessey; Seed Production and Disseminations as Accessory Characters, Mr. F. E. Clements; Statistics Ecological and Distributional of Nebraska Grasses, Mr. Roscoe Pound; The Origin of the rudimentary Ovules in Clematis, Mr. Ernst A. Bessey.

SCIENTIFIC NEWS.

Prof. Edward D. Cope died in Philadelphia, April 12, 1897, aged 56 years.

Among the recent calls and advancements in position we note the following: Karl Futterer to the professorship of mineralogy and geology in the Technical School at Karlsruhe; Peter August Pauly to the head of the zoological institute of the experiment station recently established in connection with the University of Munich; Dr. Erich Wernicke to be professor extraordinarius of hygiene in the University of Marburg; Dr. Alexander P. Anderson to the professorship of botany in Clemson College; Dr. Fritz Noll to be titular professor of physiology in the University of Heidelberg; Dr. Carl Burckhardt, of Basel, to the position of geologist in the Museum of La Plata; Dr. Leo Wehrli, of Zürich, to be mineralogist in the same institution; Dr. Lugni Buscalioni, of Turin, to the assistantship in the Botanical Institute of the University of Rome; Dr. Pietro Cannarella to be assistant in the Botanical Garden at Catania; Anton Pestalozzi, assistant in the Botanical Museum of the University of Zürich; Dr. Johannus Petruschky to the directorship of the Hygienic-Bacterological Institute in Danzig; Dr. Hermann Ross, of Palermo, to the position of custodian of the Botanical Gardens of Munich; Wladimir Iwan Palladin, of Charkoff, to the professorship of Botany in Warsaw; Dr. Siedentopf, of Göttingen, to the position of assistant in mineralogy in the University of Griefswald; Dr. Karl Eckstein to be titular professor of zoology in the Academy of Forestry at Eberswalde; Dr. Ludwig Plate to be titular professor of zoology in the University of Berlin; Dr. William E. Castle to the instructorship of biology in Knox College; Dr. Romeo Fusari to the professorship of human anatomy in the University of Modena; Dragutin Gorjanovish-Kramberger to the professorship of geology and paleontology in the University of Agram; Anton Heinz to the professorship of botany in Agram; Dr. Mijat Kishpatish to the professorship of mineralogy and petrography in Agram; Dr. Hans Lenk, of Erlangen, to the professorship of geology and mineralogy in the University of Würzburg; Dr. Giulio Valente, of Perugia, to the professorship of human anatomy in the University of Catania; A. Engler to the professorship of forestry in Zürich; Dr. Walter Felix to be professor extraordinarius of osteology in Zürich; Dr. Siegfried Mollier, of Münich, to be professor extraordinarius of anatomy in Göttingen; Dr. Umberto Rossi, of Florence, to be professor extraordinarius of human anatomy in Perugia; Dr. Joseph Kriechbaumer to be conservator of the Zoological Collections in Munich; J. J. Luehmann to

the directorship of the Herbarium of Melbourne; Johannes Rüchert to the professorship of descriptive and topographical anatomy in the University of Munich; Pasquale Baccarini to the professorship of botany in the University of Catania; Prof. Alexander Fischer von Waldheim, of Warsaw, to the position of director of the Botanical Gardens in St. Petersburg; Dr. Oswald Kruch to the professorship of botany in the Agricultural Institute in Perugia; Isaac H. Burkell, of Cambridge (Eng.), to a position as assistant in the Kew Herbarium; Emilio Chiovenda to the conservatorship of the Botanical Collections of the University of Rome; Dr. Biagio Longo as assistant in the Botanical Institute of the University of Rome; Dr. Achille Terracciano as assistant in the Botanical Institute of Palermo; Dr. Beckenkamp, of Mülhausen, to the professorship of mineralogy at Würzberg; Dr. Gaupp to be professor extraordinarius of anatomy at the University of Freiburg.

Recent Deaths:—Dr. Emile Moreau, ichthyologist, at Paris, September 11, 1896; Joseph Chappell, entomologist, at Manchester, Eng., October 3, aged 67; Dr. Rudolf Raimann, botanist, as Vienna, December 5, aged 33; Joseph Ullepitsch, botanist, at Wilfersdorf, Austria, December 16, at the age of 68; Professor Joseph von Gerlach, anatomist, of Munich, December 17, aged 76; Ferdinand Morowitz, Vice-President of the Russian Entomological Society and a student of Hymenoptera, December 17, aged 70; Lugui Calori, professor of anatomy in the University of Bologna, December 19, aged 90; Dr. Theodor Lickfett, director of the Bacteriological Institute in Danzig, December 28, aged 49; Heinrich Gaetke, ornithologist, of Helgoland, January 1, aged 83; Franz von Baur, Professor of Forestry, at Munich, January 2, aged 66; Dr. August Streng, professor of mineralogy, at Giessen, January 7, aged 67; Dr. A. A. van Bemmeln, director of the Zoological Garden at Rotterdam, January 9; Dr. Karl Heitzman, anatomist, at Rome, aged 61; Sven Anders Bernhard Lundgren, professor of geology in the University of Lund, January 7, aged 53; Alois Rogenhofer, student of Lepidoptera, at Vienna, January 15, aged 65; Salvatore Trinchese, professor of comparative anatomy in the University of Naples, January 18; Hermann von Nordlinger, formerly professor of forestry in the University of Tübingen, at Stuttgart, January 19, aged 78; Frederick Isaac Warner, botanist, at Winchester, Eng., November 8, aged 54; Antonio Cecchi, African traveller, killed by the natives in Somali Land, November 26; Dr. Paul Taubert, botanist, at Manaos, No. Brazil, January 1; C. F. Wiepkin, for nearly 60 years director of the Museum at Oldenburg, January 29; Constantin, Baron

of Ettinghausen, phytopaleontologist and professor of botany in the University of Graz, February 1, aged 76; Dr. Otto Buchner, in Giessen, February 5, aged 68 years; Dr. Filippo Togrini, conservator of the Botanical Institute at Pavia; Ernst Georg Dannenberg, lichenologist, at Fulda, Germany, December 4; M. Thollen, botanist and chief of the exploration of the French Congo, at Libreville, January; Jean Baptiste Barla, director of the Natural History Museum in Nice; Dr. Berthand, professor of geology in Lille; Georg Gercke, student of Diptera, in Hamburg; Jaroslar Koshtal, assistant in zoology in the Technical School at Prague.

Veteran Scientist Honored.—The Kansas Academy of Science at its recent annual meeting at Topeka placed the name of Chaplain John D. Parker on the roll of life members, as a recognition of his effective services in organizing science in the west. During the last thirty years he has originated the following scientific associations, viz.: Kansas Academy of Science, Kansas City Academy of Science, and California Science Association. The Indiana Academy of Science and the Ohio Academy of Science were organized on the plan of the Kansas Academy of Science, and under the scientific impulse derived from it, and the Ohio Academy of Science was originated by one of its former members. The field occupied by these academies contains a third of a million square miles, and about 10,000,000 people, whose opportunities for scientific knowledge have been greatly increased by these societies. About 1,000 men and women are connected with these associations, representing every branch of science, and many of these scientists have become distinguished in their various departments.

Chaplain Parker says he has pursued this life work most assiduously, but at times under great financial discouragements, and sometimes in sickness and pain and feebleness, still it has been the joy of his life, and he has great satisfaction in knowing that his associates and fellow workers have accomplished such a noble and enduring work for science.

When Chaplain Parker came to San Diego five years ago, his physician despaired of his life. Now, under the magical influence of this climate, his health is nearly recovered, and he looks forward hopefully to future years of usefulness.—*The San Diegan Sun.*

Mr. Lawrence Bruner, of the University of Nebraska, has sailed to Argentina to study the ravages of the locusts, which have recently developed into a terrible pest, certain regions being completely devastated by them. The Argentine Government has appropriated $400-000 for relief while a syndicate of business men have raised funds to

employ an entomologist to study the question. Mr. Bruner will remain a year at their expense. His labors as an economic entomologist have especially fitted him for this work. His place at Nebraska will be filled by his assistant, Mr. Hunter, during his absence.

The National Academy of Science has appointed Dr. Theodore N. Gill to prepare the biography of the late Professor Cope. Professor Cope was to have delivered the address as retiring president before the American Association for the Advancement of Science at its Detroit meeting. Dr. Gill as first vice-president will be the acting president and will deliver a memorial address upon the scientific work of Professor Cope.

The following persons have recently qualified themselves for the position of privat-docent: Dr. Alfred Bergeat for geology in the University of Munich; Dr. René Du Bois Reymond for physiology in the University of Berlin; Dr. A. Landauer for physiology in the University of Budapesth; Dr. Franz Nissl for anatomy in the University of Heidelberg; Dr. Heinrich Sachs for anatomy in the University of Breslau.

Professor Johannes von Kries, of Freiburg, who was called to the chair of physiology in the University of Berlin, as successor to the late Professor Du Bois Reymond, has decided to remain in Freiburg.

Dr. Henri Filhol, professor of anatomy in the Museum of Natural History of Paris, has been elected to membership in the Academy of Sciences of Paris, as successor to the late Professor Sappey.

Dr. F. Saccardo, professor in the enological school at Avellino, and known for his studies of lichens, died Oct. 6, 1896, aged 27 years. He was a nephew of Dr. P. A. Saccardo, the mycologist.

Dr. W. A. Rothert has been advanced to the position of professor extraordinarius of botany in the University of Kazan, and Dr. O. Seeliger to the chair of zoology in the University of Berlin.

Dr. Beer has qualified as privat-docent in comparative physiology in the University of Vienna, and Dr. R. Krause as privat-docent in anatomy in the University of Berlin.

Among other recent deaths we notice those of S. Scholz-Rogozinski, African traveler; P. Briard, mycologist; A. S. Smith, ornithologist, and Dr. G. W. Child, botanist.

Professor Karl Alfred von Zittel, professor in paleontology in Munich, has been elected corresponding member of the Academy of Sciences in St. Petersburg.

Dr. J. A. Oudemanns has resigned his position as director of the Botanical Gardens at Amsterdam, and Dr. Hugo de Vries has been appointed as his successor.

The government of the Transvaal, South Africa, is about to establish a University at Pretoria. Instruction will be given in the Dutch language.

The Royal Academy of Sciences, in Berlin, has elected Professor E. H. Ehlers, of Göttingen, to associate membership in the class of zoology.

Prof. B. C. Brühl, for nearly forty years professor of anatomy in the University of Vienna, has resigned and removed to Gratz.

S. Flower, the son of Sir W. H. Flower of the British Museum, has gone to Bangkok as director of the Royal Museum of Siam.

Dr. O. Penziz, professor of botany in the University of Genoa, has gone on a long trip for botanical study in the East Indies.

Miss A. M. Claypole has been appointed instructor in zoology, and Miss J. Evans instructor in botany in Wellesley College.

Dr. G. Dewalque, professor of physical geography and geology in the University of Liege, has resigned on account of age.

The Academy of Sciences of Paris has elected the mineralogist Gustav Tschermak, of Vienna, to corresponding membership.

Dr. H. G. Hallier has resigned his position in the Botanical Station at Buitenzorg, Java, and has returned to Germany.

Prof. M. Schiff, who occupied the chair of physiology in the University of Geneva, died Oct. 6, 1896, at the age of 73.

The director of the Bacteriological Institute of the University of Vienna, Dr. R. Kerry, died Oct. 19, 1896.

W. Whitaker, for forty years district surveyor of the Geological Survey of England, has resigned his position.

Dr. Rudolf Schäfer has resigned his position as custodian of the paleontological Collections in Munich.

Professor Alfred Hughes, of the chair of anatomy in the University College, Cardiff, Wales, has resigned.

Professor W. Kühne, of Heidelberg, has refused a call to Berlin, as a successor to Du Bois Reymond.

Dr. F. Graeff, of Freiburg, i. B., goes to the University of Breslau as professor extraordinarius of mineralogy.

Dr. F. von Müller, government botanist at Victoria, died at Melbourne, Oct. 9, 1896, aged 71.

Dr. Müller has resigned his position as director of the Zoological Gardens at Königsberg, i. P.

Dr. J. A. Moloney, the African traveler, died in Surtiton, So. Africa, Oct. 5, 1896, aged 36 years.

F. A. Hazslinsky de Hazlin, the nestor of Hungarian Botanists, died in Eperjes, Nov. 19, 1896.

Dr. Teodoro Caruel, professor of botany in the University of Florence, has retired.

Prof. A. Negri, geologist and paleontologist of Padua, committed suicide Dec. 11, 1896.

Prof. A. Batalin, director of the Botanical Garden at St. Petersburg, died Oct. 15, 1896.

Sir B. W. Richardson, histologist, died in London, Nov. 21, 1896, aged 68 years.

E. C. Thurber, ornithologist, died September 6, 1896, at Alhambra, California.

Thomas Egleston, Professor of Mineralogy in Columbia College, has resigned.

A. Trecul, botanist, of Paris, died Oct. 17, 1896, at the age of 70.

The following important announcement is extracted from a private letter just received by the Managing Editor pro tem. of this journal from Prof. Th. Tschernychew, and relates to regulation of the Committee of Organization of the International Geological Congress by which it would be well for all universities and scientific societies to profit. The translation follows:

International Geological Congress, 7th Session, 1897. ST. PETERSBURG, April 3, 1897.

Honored Sir:—In answer to your letter of the 25th of March I have the honor to announce that all Scientific Societies which inscribe themselves members of the Congress will receive its publications. The bureau considers it a duty to thank you for having distributed its circulars to geologists in America, and to inform you that from this time

on the number of persons who have inscribed themselves is so great—nearly 700—that it will be absolutely impossible to enable them all to take part in the excursions.

As to the delegates of the different scientific institutions, the Committee of Organization, desiring to follow the precedent established by former Congresses, hopes that each of those institutions which desires to have itself represented by a delegate will not fail to announce his name in advance.

Accept the assurance of my most distinguished consideration.

TH. TSCHERNYSCHEW.

DR. PERSIFOR FRAZER,
Room 1042 Drexel Building,
Philadelphia, U. S. A.

Learned societies and other similar bodies which desire to profit by this permission, should address Mr. A. O. Michalski, Comité Géolgique, St. Petersburg, Wassili Ostrow. 4^{me} ligne, enclosing a draft for twenty-two francs and specifically stating the name of the Society which wishes to be inscribed a member of the Congress, and also that in addition to the twelve francs which are sent as membership dues, ten francs are added for the livret guide (which will contain very valuable information).—P. F.